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Vol. XXIII., No. 1. 1897. Whole No. 81.

PROCEEDINGS

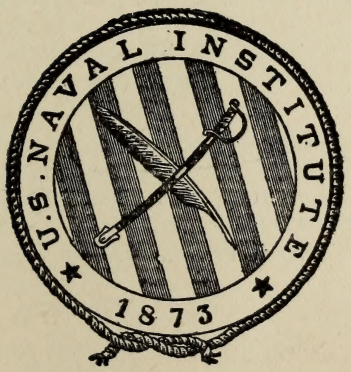
OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XXIII.

29



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PUBLISHED QUARTERLY BY THE INSTITUTE.

ANNAPOLIS, MD.

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NOTICE.

ANNAPOLIS, MD., *February 10, 1897.*

Having carefully read the four essays submitted in competition for the prize offered by the U. S. Naval Institute for the year 1897, we have the honor to announce that, in accordance with Article XI. of the Constitution, the prize is awarded to the essay bearing the motto, "Everything in order," on Torpedo-Boat Policy, by Lieutenant R. C. Smith, U. S. Navy.

Honorable mention is accorded in the order named to the essays bearing the mottoes: (1) "From little spark may burst a mighty flame," on A Proposed Uniform Course of Instruction for the Naval Militia, by Mr. H. G. Dohrman, Associate Member, U. S. Naval Institute; (2) "And another came, saying, Lord, behold, here is Thy pound, which I have kept laid up in a napkin; for I feared Thee, because Thou art an austere man," on Torpedoes in Exercise and Battle, by Lieutenant John M. Ellicott, U. S. Navy.

EDWIN WHITE, Commander, U. S. Navy.
ASA WALKER, Commander, U. S. Navy.
B. F. TILLEY, Commander, U. S. Navy.
E. B. UNDERWOOD, Lieutenant, U. S. Navy.
DAVID DANIELS, Lieutenant, U. S. Navy.
N. M. TERRY, A. M., Ph. D.,
Professor, U. S. Naval Academy.
H. G. DRESEL, Lieutenant, U. S. Navy.
Members, Board of Control.

NOTICE.

Further discussions on articles in this number are requested. They will be published in succeeding numbers.

H. G. DRESEL, Secretary and Treasurer.

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THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XXIII., No. 1. 1897. Whole No. 81.

PRIZE ESSAY, 1897.

MOTTO: "Everything in Order."

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TORPEDO-BOAT POLICY.

BY LIEUTENANT R. C. SMITH, U. S. Navy.

INTRODUCTORY.

It seems probable that the United States, after many years hesitation, is now about to enter on a policy of torpedo-boat construction. The desirableness of such action is hardly open to criticism.

We shall have twenty-three boats of the different classes when all that are now authorized shall have been accepted. An inspection of the lists of foreign warships will show that the ratio of torpedo-boats to other classes is nearly as two to one. Our ratio at present is more nearly the reciprocal of this.

It cannot of course be assumed that in every country there is the same ratio to be observed between the various elements of the fleet. The numbers of torpedo-boats, for instance, will be influenced by the general policy and the extent and character of the coast, as well as by the actual size of the navy. It is not intended here to take up more than casually the question of the number of boats it would be desirable to build in the United

States, but it may be remarked in this connection that whatever arguments have been advanced in other countries in favor of torpedo-boats, either in reference to their use with the squadron as circumstances indicated, or to the special features of the coast which might lend themselves to torpedo-boat operations, apply with if anything greater force to the case of the United States.

It has been held abroad that torpedo-boats are the weapon of the weaker naval power. A power that is strong in ships will be able to bring commanding numbers against the ships of a weaker enemy. She has no imperative need for many torpedo-boats. On the other hand, the weaker power here finds its opportunity. The latter requires torpedo-boats, the former torpedo-boat destroyers. Continuing the argument, a nation which may be attacked by superior numbers on its own coast may find the torpedo-boat a weapon of the greatest value.

But it is when the natural features of our coast are considered that the argument in favor of torpedo-boats presents itself in the strongest light. The extent and configuration of the coast, and especially the amount of inland-water navigation, seem to make the torpedo-boat a weapon peculiarly suited to our special requirements.

Thus there cannot be any reasonable doubt as to the desirableness of increasing materially the torpedo-flotilla; but there may be, and in all probability is, considerable doubt as to the characteristics of its components. In the past twenty years there have been first and second-class torpedo-boats, sea-going torpedo-boats, torpedo-cruisers, torpedo-rams, torpedo-gunboats or catchers, torpedo-vedette-boats, torpedo-boat destroyers. Which of these different types should we copy after for the present, and what should be the military features of the types selected? As we have little experience of our own, the practice of other nations will be for the present a useful guide.

It is necessary here to review, in a general way, the course of torpedo-boat construction abroad, after which we shall be in a better position to form an opinion as to our own needs.

The vessels to be considered are those in which the automobile torpedo forms the chief or a very important feature of the armament. Submarine torpedo-boats are not here included. The subject is a large one in itself, and requires separate treatment.

Torpedo-Boats Proper.

The modern torpedo-boat, from all accounts, owes its origin to the fast launches fitted for spar-torpedoes, built first by Thornycroft, Yarrow and the Herreshoffs. When machine and rapid-fire guns practically put an end to this form of weapon, it was a step only to the automobile torpedo in the same type of boat.

A precursor of the spar-torpedo launch was the Miranda, a fast river-launch, built by Thornycroft in 1871. She was just short of 50 feet in length, and made 16¼ knots, at that time an unprecedented speed. The hull was of Bessemer steel. She had two cockpits and a low glass deck-house. A locomotive boiler supplied steam at 120 pounds pressure to a two-cylinder vertical engine. Here were many features of later torpedo-boats.

In 1873 Thornycroft turned out a torpedo-launch for Norway, which I believe was called the Rasp, and which was a great advance on any previous attempt. This boat was 57 feet long and made 17¼ knots on trial. She had compound engines and the usual locomotive boiler. She was fitted to tow a torpedo from the top of the smoke-pipe. The Glimt for Sweden in 1875 was very similar and made 18 knots.

The Herreshoffs were among the earliest in this field. Their Lightning was built for the Bureau of Ordnance in 1876. She was a wooden launch of 58 feet over all and weighed about three tons. The boiler was of the patent safety-coil type, supplying steam at 140 pounds pressure to a two-cylinder 5 by 10 engine running at 400 revolutions a minute. This boat actually made in 60 minutes on trial 20.3 statute miles with and against the tide, equivalent to 17.6 knots. She was fitted for the spar-torpedo.

A noted boat of this time (1876) was the Gitana, a yacht built by Thornycroft for the Baroness Rothschild to run on Lake Geneva. She was of steel plates, 86 feet long on the water, and displaced 29 tons. A locomotive boiler supplied steam at 100 pounds pressure to a three-cylinder compound engine running at 325 revolutions. She was guaranteed to make 36 miles in 2 hours, but actually made 43 miles in 1 hour and 48 minutes, or at the rate of 20¾ knots.

Thornycroft's Lightning for the British government dated from 1877. She was 84 feet long and was designed for 18 knots, but made 19.4 on preliminary trials. This was the first real

torpedo-boat. Her armament was the Whitehead torpedo discharged from the forward deck. She was made rather heavier and with fuller lines than her predecessors, in order to withstand rough weather if necessary. She also had more complete cabin arrangements to permit remaining at sea for longer intervals. Her engines made 350 revolutions with 120 pounds of steam. In other respects she resembled earlier boats.

Messrs. Yarrow & Co., of Poplar, had also turned out a number of fast launches of various sizes. Their first torpedo-boat was built for the Argentine in 1874. She was of steel, 55 feet long and made 12½ knots on 65 indicated horse-power. She was fitted for the McEvoy spar-torpedo.

In 1877 they built Nos. 17 and 18 for the English government. These boats were 86 feet long, of 33 tons displacement and made 21 knots on 450 indicated horse-power. Their armament was two torpedo-tubes. No. 14, by the same firm the following year, was practically the same size, but made 21.94 knots on 550 horse-power, and was the fastest vessel of its day.

Boats now began to be known as first and second-class, according as they were of a size to act independently or were designed to be carried on shipboard. The distinction still holds generally, though boats for ships are sometimes now called third-class.

The second-class boats were first fitted with side frames for discharging the 14-inch torpedo. The torpedo was lowered over the side and was started parallel to the keel-line by its own motive power, using a laniard to haul back the starting lever. The speed of the boat required to be reduced to permit this.

Steam was next used for the discharge. The torpedoes were laid in troughs on the forecastle and ejected by a steam piston with a stroke of 7 feet. This method did not require the speed of the boat to be slackened. It was designed by Yarrow.

Air-discharge was the next form, and this was used mostly in the larger boats, until followed much later (about 1884) by the now almost universal gunpowder method.

In 1878 there were several French boats, built by various firms, of 108 feet and 45 tons. Their speed was 19 knots. They had two torpedo-tubes.

The Herreshoffs built a boat for the English government in 1879. She was fitted with one of their coil boilers. The first

apparent effect on English practice was the fitting of second-class boats to take live steam from the ship's boilers through a flexible pipe, in order to hasten the time of getting underway. Thornycroft's tubulous boiler followed about four years later, the first of which went into a Missionary steamer on the Congo. The Herreshoff boat was about 60 feet long and realized 16 knots. There were several novelties besides the coil boiler. She was of composite structure with steel frames, planked below the water and plated above. The shaft inclined downward at first, but was brought back to the horizontal by running it through a curved brass tube which gave it a long bearing. The shaft had sufficient elasticity to revolve in this position. The screw was well under the body of the boat. The long bearing formed a sort of fin-keel, as well as a surface condenser for the exhaust steam. As the deadwood was cut away abaft the screw, it also formed a pivot for turning and made the boat very handy.

In 1880 Thornycroft had reached a type of first-class boat for England, 90 feet long with a speed of 22 knots. This boat was fitted with a ram bow as a result of an experience in a collision at Portsmouth in February, 1880, in which a boat with a straight stem had her bow completely stove in against the side of another boat. Apropos of this, Mr. Donaldson, of the Thornycroft firm, said in a lecture before the Royal United Service Institution in April, 1881, "All our boats are now fitted with the ram bow, strengthened so as to be useful as a means of offense in an action between boats." This principle seems to me a very important one and will be referred to again.

The armament of this boat was three Whitehead torpedoes, two in transporting carriages, one on each side of the deck, and the third in a tube on the bow. The tube was pivoted, permitting it to be trained ahead and on either beam. The torpedo was ejected by a telescopic impulse tube actuated by compressed air.

The Batoum was built by Yarrow for Russia in 1880. She was 100 feet long and made 22 knots. She was the first so-called sea-going torpedo-boat, and made the trip from London to Nikolaief, 4800 miles, at an average speed of 11 knots. She was fitted with twin bow tubes and carried four 19-foot Whiteheads. This was the first boat to be fitted with a turtle-back deck.

In 1881 Thornycroft built a boat for Denmark, the Svaerd-

fisken, of 110 feet, with twin bow tubes and an armament of four 19-foot, 15-inch Whiteheads. The discharge was by compressed air admitted in the tube behind the torpedo, which is the present method with air-discharge. Her torpedoes carried a charge of 80 pounds of gun-cotton and had a speed of 20 knots for 1000 yards. This boat was guaranteed to make 18 knots for 3 hours, but was expected to exceed that speed. She actually made 20.

In 1882 Yarrow completed a 100-foot boat for Italy of the Batoum type which made 22½ knots on trial. This was the highest record to date. This was considered to be a very efficient sea-going type. Ten similar boats had been navigated to the Mediterranean the previous year, and two across the Atlantic. This boat had all the Yarrow special features, such as bow and stern rudders, turtle-back deck and water-tight ash-pan. The bow rudder had been first used in 1878. It was arranged to raise and lower, or to drop altogether if it became entangled. Used in conjunction with the after one, it reduced the diameter of the turning circle practically one-half. The turtle-back deck has since become very common. It sheds the seas well, but a greater advantage is the added strength it gives to light structures by its curved surface. The water-tight ash-pan was an arrangement to prevent extinguishment of the fires in case the compartment was flooded.

Schichau, of Elbing, had also built torpedo-boats. In 1882 this firm built two boats for Italy of 100 feet and 40 tons, with a speed of 22 knots. The armament was two torpedo-tubes and a revolving-cannon.

The torpedo-boat had grown precariously to this stage in its existence. It had had its ups and downs, but through the exertions of builders and of officers who had faith in its mission, it had continued to develop.

It started off very well about the time the automobile began to displace the spar torpedo, and it was no longer necessary for the attacking boat actually to reach the side of the enemy. A very ordinary automobile torpedo had evidently many advantages over the spar-torpedo. But the revolving-cannon and the rapid-fire gun made their appearance, and in the then development of both torpedo and launch, the balance between attack and defense was, if anything, more than restored. The search-light and the defense-net capped the climax in favor of the defense.

But the torpedo continued to improve in speed and range and the torpedo-boat in size and speed. In fleet exercises and drills the boats occasionally scored successes, notwithstanding the search-lights, rapid-fire guns and defense-nets. We have followed the progress of the boat; the torpedo had kept pace with it. From a speed of 6 knots in 1867, it had increased to 20 knots in 1876, and to 24 knots in 1882. The range had also increased with the speed.

The torpedo-officers remained unshaken, enthusiasts they were called by their opponents, but it is worth noticing, however, that the enthusiasm came from a practical knowledge of the weapon, and represented the balance to the good after discounting uncertainties and failures.

But the boats were again to fall into disfavor. They were still small compared with those of to-day. Their endurance in coal, water, and provisions was limited; they were barely seaworthy; and, through buffeting, their crews were rapidly exhausted when cruising continuously in all weathers. Then, with their light and fast-moving machinery, breakdowns were numerous. The boats were sources of anxiety to the Admirals in command, and frequently had to be sent to port under convoy.

From now on, through this part of the subject, an attempt will be made to indicate the trend of opinion by a selection of quotations coincidently with a brief enumeration of the various types of boats as they appeared.

The firm of Normand & Co., of Havre, had built some of the French boats of 1878. In 1883 they built the Poti for Russia. She was 125 feet long and displaced 72 tons. She made 18½ knots on 570 horse-power. Her armament was two tubes and two revolving-cannon.

Between 1883 and 1890 the Elbing firm built sixty-three boats for Germany, now on the navy list, of from 121 to 128 feet, and 85 to 88 tons. On 1000 indicated horse-power they made from 19 to 22 knots. Their armament is two torpedo-tubes and two revolving-cannon.

Mr. J. S. White, of East Cowes, was the originator of the turn-about system of boats. By cutting away the deadwood aft and sometimes fitting a second rudder under the bow, he increased the manœuvering power considerably. One of the best known of his boats was the Swift for the English government in 1885.

She was 150 feet long and displaced 125 tons, quite a large boat for her day. She was sometimes referred to as a torpedo-catcher. Her trial speed was 20.8 knots. She had a three-cylinder compound engine and two locomotive boilers. The armament was two torpedo-tubes and six 3-pounders.

The Adler and Falke, by Yarrow for Austria in 1885, were the fastest boats to date. They were of 135 feet and 95 tons and made 22.4 knots on 1250 horse-power. This speed was probably exceeded at times, for Yarrow's boat for Italy in 1882 was credited with 22½ knots. The armament of the Adler and Falke was two bow tubes and two Nordenfelt guns. *Engineering*, January, 1886, page 14, has the following: "The bow of these boats is specially strong, the maximum weight of metal being put forward so as to stiffen the boat for ramming."

In this year and the next (1885-6) Thornycroft, White and Yarrow built fifty or sixty boats for England, varying from 113 to 128 feet, and from 60 to 75 tons. Their maximum speed was 22 knots. They carried two 3-pounders and from one to five torpedo-tubes. Lord Brassey states in the Annual for 1886, page 83, that these boats, which were laid down at the time of the Russian war-scare, were intended for use in the Baltic. It was expected that the Russian ships would be found locked up in port where torpedo-boats could not get at them, but that the English ships would be subject to attacks by the Russian boats. Hence these boats would probably have gone out with gun armaments alone, to act as a protection to the fleet against the Russian torpedo-boats. This idea anticipated by several years the modern torpedo-boat destroyers, which are really large and fast torpedo-boats with a heavy gun armament.

A suggestion to the same effect, but of a much earlier date, was made in a letter to the London *Engineer*, April, 1878, page 296, signed "Engineer." It was there advocated that each battleship should be protected from torpedo-boats by a small fast vessel of not less than 20 knots speed, with a sharp bow strengthened for ramming, and mounting a single bow-chaser. This vessel was to circle around the battleship at a distance of 500 yards and run down or destroy by gun-fire any hostile boat that might be encountered.

The following is the decision of the British Admiralty Board in regard to torpedo-boats, after the manœuvres of 1886, as quoted in Brassey, 1887, page 514:

"The practical tests during recent evolutions imposed upon first-class torpedo-boats, that is, boats intended for open sea service, and upwards of 100 feet in length, have shown that they could not, in actual warfare, stand the strain of the daily wear and tear to which they might be exposed. The discomfort and hardships which their crews have to endure in rough weather, the loss of speed to which, after steaming a certain number of hours at full pressure, they are subject, owing to the tendency of their necessarily contracted boiler tubes to choke, disqualify boats of these dimensions from taking the prominent part in warfare in the open seas which their adherents claim for them. The Board have therefore decided in future to build for sea-going purposes vessels of larger dimensions, capable of acting both on the offensive and defensive in torpedo-warfare, in the open sea. These vessels to be of the Rattlesnake type, capable of maintaining for many hours the initial speed of the ordinary torpedo-boat, armed with quick-firing guns, and another gun of a larger calibre, and affording adequate accommodations and protection to the complement they carry for sea-going purposes.

"The Board have decided upon adopting a new type of second-class torpedo-boat, capable of being lifted on board ships of a certain displacement, and which would be carried by the ship for service in the place of the larger or first-class torpedo-boats which are now supposed to accompany a squadron.

"The 125-foot torpedo-boats now building or built have, in most instances, been allotted to the defense of the great military ports and coaling stations, where they will remain."

We see here the line of argument that led to the torpedo-gun-boat or torpedo-boat catcher. The decision in regard to the 125-foot boats is scarcely open to criticism. Boats of that size must necessarily operate from a near-by base, which they can seek for shelter from the weather, or when pursued by the enemy, or to complete stores.

The decision as to second-class boats was apparently a retrogression. The weight of opinion then and now was opposed to them, and for reasons which were well stated the previous year by *Engineering* (December, 1885, page 616):

"It would seem as if second-class torpedo-boats have become a thing of the past, so far, at least, as building any fresh ones is concerned. It is a question whether so small a class as a 60-

foot boat could ever be used effectively against an enemy excepting under the most favorable conditions. In addition to this the second-class boats are useless for any general purposes in times of peace, and occupy a vast deal of space on board the vessels that carry them. The great improvements in speed made lately by the larger navy pinnaces have made the second-class boats less necessary, as the pinnaces carry torpedoes and are a far handier and more seaworthy style of craft; useful also for general purposes as a ship's steam launch."

The French at this time (1886) were building the Balny class, so-called sea-going torpedo-boats (*torpilleurs de haute mer*) of 135 feet and 70 tons, armed with twin bow tubes and two revolving-cannon. They were designed for 22 knots.

A since celebrated boat of that day (1886) was the Kotaka by Yarrow for Japan. She was 170 feet long and displaced 190 tons. With 1400 indicated horse-power she made 19 knots. She carried six torpedo-tubes and four machine guns. This boat is one of the largest of the torpedo-boats proper, and in size could be classed as a destroyer. She is very completely subdivided and is protected by 1-inch plates over the machinery space. In company with other boats, she was under the fire of the forts in the attack on Port Arthur and suffered less than any.

In 1886 Messrs. J. & G. Thomson, of Clydebank, Glasgow, built the Wiborg for Russia, of 142 feet and 142 tons, armed with twin bow tubes and a training tube on deck for 19-foot torpedoes, and two revolving-cannon. Her speed on trial was 20.6 knots. This vessel embraced a number of novel features, among them ¼-inch plating on the bow, and an inner skin in wake of the water-line forward, with cellular spaces to be filled with an obturating substance. The attack was to be bows-on, to take advantage of the protective features. After the discharge, the vessel was to back off at full speed. The stern rudder was of a form suited to this use, and there was a second rudder under the bow. She carried 45 tons of coal, sufficient to steam 4000 miles at 10 knots. She was one of the first twin-screw torpedo-boats.

The Russian boats Revel and Sveaborg were built by Normand at this time (1886). They were 152 feet long and displaced 96 tons. With about 800 indicated horse-power they made 22 and 19.7 knots respectively. They had a very good

coal capacity for their horse-power, 30 tons, and were considered very effective boats. They carried two torpedo-tubes and two rapid-fire guns.

In 1886 Schichau sent out a 144-foot boat to China under her own steam. She had twin bow tubes and four machine guns. The speed was 24.2 knots for one hour on 1597 indicated horse-power. The coal endurance was 3000 knots at economical speed.

In 1887 Yarrow built No. 80 for England. She was 135 feet long, with 105 tons displacement, 1540 indicated horse-power, and a speed of 23 knots. She carried five torpedo-tubes and four 3-pounders. She was in dimensions and performance a close approach to our Cushing.

His two boats for Italy the same year were quite similar, but made 25.1 knots, the then highest speed.

Two weeks later, the Ariete for Spain, by the Thornycrofts, made 26.1 knots, exceeding Yarrow's boat by a knot. She was 148 feet long, of 97 tons displacement and 1600 indicated horse-power. She was fitted with twin bow tubes and carried four 3-pounders. This boat exemplified all the main features of the Thornycroft construction. She had tubulous boilers, and patent double rudders outboard of the screws. The stern was flat and hollowed out underneath to give a good run of water to the screws, and to prevent squatting.

The same firm built the Coureur for France in 1887, a boat of 148 feet and 120 tons, with a speed of 23½ knots. She was regarded as a very efficient type and showed excellent sea-going qualities.

The following are extracts from the report of the Committee on Naval Manœuvres, 1888, Admiral W. M. Dowell, Chairman, as quoted by Brassey, 1888-9, page 416:

"As to 'The value of torpedo-gunboats, both with the blockading and blockaded fleets, and the most efficient manner of utilizing them.'

"Torpedo-gunboats of high speed and good coal capacity would be of incalculable value to the blockading fleet, but torpedo-boats of any class at present in use would be of far more value to the blockaded squadron than to the blockaders. Torpedo-boats, if not capable of keeping the sea independently, under all conditions of weather, would inevitably prove a cause of embarrassment and anxiety to an Admiral commanding a blockading fleet, and would be subject to endless casualties.

"First-class torpedo-boats might, with advantage, accompany a fleet if carried in a specially constructed vessel—superior class of Hecla—provided with suitable hydraulic cranes for hoisting them in and out.

"Second-class torpedo-boats, as carried in the ironclads, will, no doubt, prove useful on occasions.

"We consider, however, the new type of Vedette-boat preferable for sea-going battleships; they are better sea-boats and, being built of wood, are less liable to damage and more easily repaired than torpedo-boats.

"The balance of opinion, in which we concur, is to the effect—

"That the employment of torpedo-boats as an inner line of blockade is not desirable, they being calculated to cause much confusion and embarrassment to their friends. That they are admirably adapted for purposes of defense; but even then, without a very simple and perfect system of signals, they are liable to be taken for enemies by their own side. The documents before us show that this actually occurred once at least on each side in the course of these manœuvres.

"That torpedo-boats should not be used as despatch-vessels, or for any purpose other than that for which they are designed.

"That torpedo-nets—certainly as at present fitted—cannot be carried by vessels under weigh without impairing their efficiency and compromising their safety."

The Aquila class for Italy were built by Schichau in 1888. They were 152 feet in length and displaced 130 tons. On 2200 indicated horse-power the Aquila made 26.6 knots. The armament was three torpedo-tubes and five rapid-fire guns and revolving-cannon. The class was reported to have turned out badly in the manœuvres of that year. Strength, seaworthiness and comfort were all sacrificed to speed, which was greater than in the 128-foot type only in smooth water. This is a lesson always to be borne in mind in attempting to get more speed than the displacement and offensive features warrant. The smaller type was reverted to for awhile in Italy, though some larger boats are now proposed.

The following is from the Parliamentary Report on the English Manœuvres of 1890, as quoted in Brassey, 1891, page 26:

"The radius of action of a torpedo-boat is limited less by her coal and feed-water supply than by the physical endurance of

her crew, especially of her commander. It has been assumed that the physical strain caused by continuous attention to the navigation of a boat at night cannot be supported for more than a very few hours, if the officers undergoing it are to arrive on the scene of operations still so unwearied that neither nerve, nor coolness, nor readiness of resource would be likely to fail them at a critical moment. During the late manœuvres it was proved by actual experience that there are officers who can navigate their boats for hours together across a crowded route, can reach their objective punctually at the prearranged time, and can then manœuvre at very high speed at night in an anchorage so filled with shipping that manœuvring in it when fresh and in broad daylight would require much care and attention. . . . A result of the 1890 manœuvres is, that opinions on the effective radius of torpedo-boat action will have to be reconsidered."

In 1890 Thornycroft built two very effective boats for the Argentine, the Murature and Commodoro Py. They were 150 feet long, of 110 tons displacement, 1500 indicated horse-power, and made 24½ knots. The armament was three torpedo-tubes and three 3-pounders. The Murature, on the trip out, steamed from Pernambuco to La Plata, 2300 miles, at 9½ knots with one engine, without stopping. The radius of action under these conditions is 2800 miles.

The Adler (1890), a Schichau boat for Russia, was of the Aquila type. She made 27.4 knots on trial and 26.55 for two hours. This was the highest speed to date.

Our own Cushing was launched by the Herreshoffs the same year. She is 138 feet in length, of 106 tons normal displacement, and 120 tons loaded. Her best speed was about 24 knots on the measured mile, and trial speed 22½ for three hours. This last was on 1720 indicated horse-power. Her armament is three torpedo-tubes for the short 18-inch Whitehead, and three 1-pounders. She has the exceptional bunker capacity of 39 tons, or 51 pounds per indicated horse-power, which is equivalent to a day's steaming at full spead. This feature of coal endurance is a most valuable one and will be referred to more at length in another place. She has at all times proved exceedingly safe, reliable and effective. Her sea-qualities could be somewhat improved by removing the bow torpedo-tube and building her higher forward with the weight thus saved.

Brassey's Annual, 1891, page 110, has the following:

"Experience has shown that the smaller torpedo-boats are unseaworthy. Those recently constructed in England are of about 100 tons displacement. Germany, Italy and Russia are building boats of 130 to 160 tons. It will probably be well to have torpedo-boats of two classes. The first class, of not less than 150 tons, should be able to cruise with the fleet within a certain distance from the coast. The second-class boats, for harbor defense, may be of small size and cheap construction. In the conditions which favor the attack by the torpedo-boat upon heavy ironclads blockading a port, a small and cheap type will be almost as effective as one more costly."

This last view is open to argument. The subject will be presented again when the different types of boats are discussed.

The Annual of the Office of Naval Intelligence, 1892, page 256, has this in regard to the French manœuvres of 1891:

"The most important lesson of the manœuvres, and one that has caused a deep impression, is the fact that the torpedo-boats were unable to follow the battleships at a speed of 12 knots even in moderate weather. Their small storage of coal and water, the excessive fatigue imposed on officers and men, when sleep and rest are out of the question, the impossibility often of cooking, make it necessary to resupply them and to change their crews every three or four days. The manœuvres have proved again that torpedo-boats are not fit to be attached to a squadron on a permanent footing; if it should go to sea for more than three or four days they cease to be an additional strength, but become a worry and an impediment. On the coast they have lost none of their importance; while they remain within reach of shelter, where they can be provisioned and coaled and their crews can rest, they are of the greatest value against hostile cruisers."

The boats referred to were one of 108 feet, two of 118 feet, and the remainder of 133 to 139 feet. These last boats ought to have given a better account of themselves. Still it is not a type to attach permanently to a squadron. We shall see later that a decidedly larger boat is desirable for such use.

In 1891 Thornycroft built three boats for Brazil of 150 feet and 150 tons. They had twin-screws, protected by double rudders outboard and a guard underneath, and the usual flat, hol-

lowed-out stern. They had two bow tubes and two single deck tubes on the middle line, all for 14-inch torpedoes. They were guaranteed to make 24 knots for two hours on 200 pounds of steam. This they exceeded, one having made 25.4 for two hours, but with 210 pounds of steam. The gun armament was out of keeping with the size of the boat—two 1-pounders.

Captain Eardley-Wilmot said, in discussing a lecture before the Royal United Service Institution by Mr. Laird Clowes in 1892:

"I quite agree with the lecturer when he says a torpedo-boat should not be looked upon as a portion of a sea-going fleet, although I think there is a tendency rather to make too much about the hardships and impossibilities of existence on torpedo-boats, because last year when the French squadron arrived at Portsmouth Harbor they had two torpedo-boats accompanying them, which the Admiral stated had been with him for six months, and had been served all through the cruise by the same officers and men, and that he found, after the first month or two, they had gradually accustomed themselves to the life."

The Corsaire, built for the French government at St. Denis in 1892, may be taken as the starting point of the present large, high-speed, sea-going torpedo-boats in vogue in that country. She is 160 feet long and displaces 150 tons. On 2500 horse-power her speed is 25½ knots. She carries two tubes for the long 18-inch torpedo, mounted on the central line and pivoting on either broadside. Her gun armament is four 1-pounders. Her coal capacity is 15 tons, which at two pounds per indicated horse-power per hour, would last her less than seven hours at full speed. This is a very limited coal endurance. As the indicated horse-power and speed are not high for a boat of that size, and the armament is not excessive, the design must be faulty; or there must be other and unnecessary weights.

In making these comparisons of coal endurance, the figure two pounds per indicated horse-power per hour *at full speed* has been taken as a basis. This is too low in most cases and makes the endurance too high. Schichau, I believe, has a record of 1.54 pounds for the Russian torpedo-gunboats Posadnik and Woewoda on their forced-draught trials in 1893, while Normand has a record of 1.86 pounds for the Forban. The English destroyers are required to conform to 2½ pounds under penalty

of a tax in the form of an added quantity of coal to be carried on trial. In the tables herewith there is a column for total pounds of coal carried per indicated horse-power, which, divided by the performance of the particular boat, will give the true endurance, subject to errors in the data, which may not always have come from reliable sources.

I may say in this connection that data in regard to torpedo-boats are very hard to get. The most reliable tables I know of are those given in the Naval Pocket-book of Mr. Laird Clowes, to whom I am indebted for a great deal of the information here used.

Our Ericsson dates from this time (1892). While this boat, through various unfortunate accidents, has not yet been commissioned (December, 1896), she is, as far as dimensions and power are concerned, a very perfect type of first-class torpedo-boat to operate from a shore base. She is 150 feet long, displaces 120 tons, and is to make 24 knots on 1800 horse-power. Her coal capacity is 40 tons, equivalent to 25 hours at full speed. The armament is three tubes for the short 18-inch torpedo and four 1-pounders.

The Pedro Ivo class for Brazil were built by Schichau in 1892-3. They are of the Aquila type. They crossed the Atlantic under their own steam, making the run from St. Vincent to Pernambuco under one boiler at 12 knots. They took part with the Sampaio in the attack on the Aquidaban in April, 1894, though they did no execution with their torpedoes.

In the Naval Intelligence Annual for 1894, page 57, is described the sea-test of two German torpedo-boats, S. 68 and S. 69, in February, 1894. They were boats of 144 feet and 110 tons (intermediate between the Cushing and the Ericsson) and were sent to sea from Wilhelmshaven in a gale of wind. There was a heavy swell and the wind was logged as 10 to 11. The boats behaved splendidly, kept up to the wind, lay-to, and ran before it at 16 knots with little racing. They were perfectly seaworthy and were not injured.

While the above speaks well for the boats, there is no certainty the crews could have stood such weather for long on a stretch.

The following are extracts from the official report on the English Manœuvres of 1894, as quoted in the Naval Intelligence Annual for 1895, page 194:

"The torpedo-boat operations were upon a too restricted scale to supply much valuable instruction, but as far as they went they tend to confirm the view that the most effective employment of the torpedo-boat in war will be limited to sending her to attack an enemy's ship in a known position within the boat's range of action, and that the whereabouts of the enemy must be first ascertained and be communicated to the commander of the boat. The necessity of combining with torpedo-boats vessels of other and larger classes to scout and discover the enemy, when exact information as to his position cannot be obtained by other means, seems to be established, and, if so, it carries with it the obligation to consider a mere flotilla of torpedo-boats by themselves as a belligerent factor of distinctly imperfect efficiency."

The Normand boat Chevalier for France was launched in 1893 and completed in 1894. She is of 144 feet and 118 tons. She has two Du Temple boilers in the same compartment, twin-screws, and made 27.22 knots on trial. Her horse-power is 2700, and coal consumption at full speed 1.99 pounds per horse-power. There are two 18-inch torpedo-tubes on the middle line and two 1-pounders. A novelty in the arrangement of the screws is that one is a little in advance of the other, permitting the blades to overlap. They were made to revolve in the same direction, with the idea of giving better water to the inner blades; but at high speed the boat has a decided list, due to the reaction, a feature which is of course not desirable.

In 1893-5 there were ten new boats built for the English government by Yarrow, Thornycroft, White and Laird. They varied from 140 to 142 feet, 100 to 130 tons, 1400 to 2700 horse-power, and 21 to 24 knots. Their coal capacity was 18 to 26 tons, equivalent to about 14 hours full speed for the lower horse-power and 11 hours for the higher. This is greater than in contemporary French boats, but seems inadequate to the objects to be attained, of which more later. These are the latest English boats, exclusive of torpedo-boat destroyers.

The Forban has become very celebrated by her high speed on light displacement. She was built by Normand for France in 1895 and displaces 130 tons on a length of 144 feet. Her indicated horse-power is 3250 and speed 31.2 knots. The armament is two 14-inch torpedo-tubes and two 1-pounders. Her

bunker capacity is 15 tons, equivalent to an endurance of 5½ hours at full speed, allowing 1.86 pounds per horse-power, which was her performance on trial. Her tremendous horse-power and speed are thus accounted for. On a given displacement, speed, endurance, and armament contend; and one predominates only at the expense of the others. A boat of her size should carry the long 18-inch torpedoes and several rapid-fire guns of at least a 3-pounder caliber. The coal endurance might with advantage be trebled. The relative value of speed, armament and coal will be discussed in another place.

On account of the interest attaching to this boat, a few more particulars are added. The speed as given above was made at 125 tons displacement. The load displacement is 136 tons. At 130 tons, with a load of 16 tons, including coal, equipment and armament, she made 31.03 knots for one hour. It is needless to say that the above allowance of weights is preposterous for a boat of 130 tons. From reliable information, the speed is gained not only by the sacrifice of weight, but also apparently at the expense of structural strength.

One of Yarrow's latest boats is the Viper for Austria, which has been delivered within a year. She is 148 feet long and displaces 120 tons. The guaranteed speed was 24 knots with 26 tons load. She really made 26.6 for three hours on 2000 indicated horse-power. The bunker capacity is 30 tons, equivalent to 17 hours' endurance at full speed. She has only a single screw, which naturally impairs the handiness and offers greater chances for disablement. Otherwise, she is in her main features an excellent type of first-class torpedo-boat.

The United States has in course of construction fifteen torpedo-boats and one destroyer. Their principal features appear in the tables. Nos. 3 to 8 are intermediate in size to the two types which it will be seen later are thought to be desirable for our service. Their armament is light for their size, 1-pounders and short torpedoes. They would be improved by the substitution of 3-pounders and long torpedoes. Their displacement amply warrants this change.

Nos. 9 and 10 are copied after the Cyclone, a Normand boat of the Forban type slightly enlarged. The coal endurance at full speed will be about 8½ hours. The armament is to be four 6-pounders and three torpedo-tubes for the long 18-inch torpedo.

Nos. 12, 13 and 14 ought to be valuable boats. They have a heavy torpedo armament and a light gun armament. Perhaps it might be advantageous to substitute 3-pounders for the 1-pounders, saving the weight necessary by omitting one of the three torpedo-tubes. Two tubes for the long 18-inch torpedo and four torpedoes make a very fair armament for a first-class boat.

Nos. 15 to 18 are too small for general use, but are warranted by considerations of inland-water navigation and length of canal locks.

The above opinions are the result of a consideration of the relative values of speed, size, coal endurance and armaments in torpedo-boats, and anticipate a discussion at some length that appears later.

Location of Tubes in Torpedo-boats.

A number of methods of mounting tubes have been mentioned. The bow tube with steam, air or gunpowder impulse was the most common until recently. In some cases there were two of them side by side, referred to as twin tubes. This method answered fairly well when the speed was not so high as at present. Now the tube in the bow makes the boats wet in a sea-way, and it could scarcely be used except in smooth water. At high speeds there is also danger of overrunning the torpedo should it not attain its own speed quickly. By omitting these tubes, enough weight is saved to build up the bow forward and improve the sea qualities.

Tactically, the bow tube, requiring to be pointed by the helm, is not so desirable as a pivoted tube with a large angle of train. Then, too, in approaching the enemy at high speed, it is awkward to have to stop and back, or else make a wide sweep, during which the boat's broadside becomes the best possible target for the enemy. With pivoted tubes, the boat can begin the turn before delivering the first torpedo, and with a small helm can launch in succession all that will bear on one broadside, and then putting the helm hard over, can soon be out of danger.

Other methods for getting the torpedo away have been by side dropping-frames, usually from the smaller boats, already described; then from turn-table tubes on deck, singly or in pairs.

Pairs of tubes on the same turn-table have sometimes been set at a small divergent angle, with the idea of launching both torpedoes together and thus increasing the chances of hitting. They have also been laid with their muzzles in opposite directions, to permit of discharge on both broadsides. Sometimes, also, they have been mounted on racers revolving around the conning towers.

The objection generally to pairs of tubes training together is that it may not always be desired to launch both torpedoes together or on the same bearing. If one only is launched on a given bearing, it may be awkward under fire, or there may not be time to train again before the second torpedo is required. Then, too, it is desirable to have the option of training either tube separately on either beam, or both tubes on the same beam, and possibly at different angles. This cannot be done with any form of double turn-table mount.

Single tubes have been mounted near the side of the boat and on the central fore-and-aft line, in the last case with train on both beams; also on top of the forecastle and near the stern, in both positions with a large angle of train on both sides of the keel line.

Single tubes at the side are exposed to the sea, especially in the turtle-back form of construction, and in consequence it would not be advisable to install other than the smaller torpedoes in these positions. The advantages are a larger command of fire *on one broadside.* In a small boat the short tube could very well be pivoted amidships, and while thus better protected from the sea, would command a fair train *on either beam.* As the spoon is in addition to the half length of tube forward of the pivot, it reaches well over the boat's rail on whichever side it is trained.

The position on top of the forecastle, while excellent in smooth water, is open to the objection of carrying the weights high, which in itself is bad in a sea-way. Moreover, the exposed position is bad for the torpedoes on account of salt spray, and the tubes would be hard to serve with much motion on.

The stern position is also good tactically, and is not open to objections on account of weather. If, however, the torpedoes are stowed for long in tubes in this position they are affected by the vibrations due to the propellers, which are here at a

maximum. If they can be stowed in other positions this objection is partially removed. On the whole, it is considered best to locate the tube where the torpedo can be kept loaded, charged and adjusted, ready for use at any time.

This reasoning points to the desirability, as a general rule, of installing the torpedoes in single tubes pivoted on the central fore-and-aft line, and at some distance from the ends of the boat. In the case of small boats, the short torpedo would be permissible, as the boat's beam would not be great enough materially to reduce the angle of train, were it not that as a type it has not been found sufficiently accurate to warrant its farther manufacture. It has been generally abandoned abroad. The standard torpedo for torpedo-boats is the long 18-inch, on account both of its greater accuracy and its larger explosive charge. While the weight is less than 30 per cent. greater than that of the short 18-inch, the gun-cotton charge is over 83 per cent. greater. The greater accuracy is due simply to its greater length, 16½ feet against 12. Two or three tubes may be carried, according to the size of the boat. The end of the spoon is 11 to 12 feet from the pivot, which takes the torpedo well clear of the side of even a large boat. By having a torpedo-carriage with the pivot towards the breech rather than the muzzle, the sweep of the spoon could be still farther increased, and angles of train exceeding 90 degrees obtained on each broadside of a boat of 20 feet beam. If a lighter torpedo is required, as for the side dropping-frames carried by vedette-launches, the long 14-inch torpedo is considered far preferable, by reason of its greater accuracy, to the short 18-inch. The explosive charges are about the same.

Smokeless powder will probably replace all other means of discharge. Air and steam require extra weight and are otherwise complicated. They are already practically replaced by gunpowder. This affords a simple means of discharge, but the pressures vary greatly with dampness. Smokeless powder gives more uniform pressures, is practically unaffected by dampness, and does not foul the tube.

Miscellaneous Torpedo-vessels.

The building of torpedo-vessels other than fast launches and torpedo-boats was preceded by one or two tentative types before the lines were definitely determined. Thus in 1874 the English

launched the Vesuvius, which was called a torpedo-ship. She was built of iron and was 90 feet long with a displacement of 245 tons and a speed of 9.7 knots. Her armament was four submerged tubes for Whitehead torpedoes. With twin screws and coke for fuel, and the products of combustion arranged to be discharged from side holes in horizontal flues, she was intended to be handy, smokeless and noiseless. Her speed was deficient.

The Italian Pietro Micca dates from 1876. She was built of iron, was about 200 feet long and of 550 tons displacement. There was an armor deck 10 inches below the water-line with sloping sides heavily plated with steel and iron. The intended speed was 18 knots, but she did not realize over 14. She was fitted with two submerged tubes and carried ten torpedoes, besides two machine guns. She was filled with machinery and had four boilers.

The Swedes built the Ran in 1877, subsequently called the Drott. She was a twin-screw iron ship of 175 feet and 630 tons, and had a speed of 13 knots. The armament was three torpedo-tubes, one submerged, and four rapid-fire guns. She was fitted also for the Harvey torpedo.

Rather a remarkable vessel of her day was the Danish armored torpedo-ship Tordenskjold, 1880. She was a steel, twin-screw, turtle-shaped vessel, with a 3.7-inch armored deck and an 8-inch armored barbette. Her length was 222 feet, displacement 2400 tons, speed 14 knots. She had a cellular double bottom surmounted by an inner ship of forty cork-filled compartments. Above this were the armament, torpedoes and crew space. There were four torpedo-tubes, over-water, five Krupp guns of from 12 to 30 centimeters caliber and eight machine guns. She carried in addition two torpedo-boats.

A somewhat similar vessel, guns excepted, was the English torpedo-ram Polyphemus, 1881. She was a twin-screw, steel, turtle-back vessel of 240 feet and 2640 tons. Her best speed was 18 knots. The armament was five submerged torpedo-tubes, forty torpedoes, six 6-pounders and two machine guns. The steel deck was two to three inches thick. She was fitted with bow and stern rudders, and could take aboard water-ballast to sink her to just awash.

The above vessels were not reproduced, though there are possibilities in some of them. A fast armored torpedo-ram may yet

be in favor, as it is not difficult to imagine cases in which such a vessel, acting singly or with the fleet, would give more than a good account of herself.

Two other types of torpedo craft may be briefly discussed here, and the way will then be clear for the cruisers, gunboats and destroyers. These are the torpedo-dépôt-ship and the German division-boat. Their principal features appear in the tables.

Of the first, the Hecla was the prototype, a British merchant steamer taken into the service and fitted for the purpose. She was followed by the Japon, the Vulcan, the Pelikan and the Foudre. The functions of the dépôt-ship were to carry spare torpedoes and stores and a large number of second-class boats to hoist out when they should be of use. They were fitted with large repair shops, and could carry relief crews for the boats as well as medical officers and stores.

The division-boat acts as the flagship of a division of torpedo-boats. It carries also spare torpedoes and stores, relief crews, medical supplies, and is fitted with repair shops, all naturally to a more limited extent than in the case of the dépôt-ships. It can be used as a scout for its division, and to a certain extent as a torpedo-boat destroyer. While these boats are about the size of the destroyers, they have not their lines or build, and the earlier ones did not have the speed. In one important feature they are very different. Their draught is 10 to 12 feet, nearly double that of the destroyers, and they are, therefore, incapable of following torpedo-boats into shoal water.

It is doubtful if either of these types can be of much value in the future. It has become apparent from the citations already made in reviewing the progress of torpedo-boats that the day of the second-class boat is perhaps past, and that first-class boats are at their best when operating from shore bases. The independent duties of the division-boats can be performed by the regular scouts or by the destroyers. Their stores and supplies will not be required by the torpedo-boats, for they will seek their own bases to renew their supplies and rest their crews; and the destroyers are capable of taking care of themselves equally with the division-boats.

The utility of the torpedo dépôt-ship disappears by the same reasoning. It may be desirable to fit up a large vessel as a floating repair shop for the whole fleet, and send her where she

is most needed. The steamer Ohio, of the International Navigation Company, was to have been so fitted had we gone to war with Chile in 1892. The French Superior Council has reported against the use of the Foudre as a dépôt-ship. Plans are under discussion to convert her to a cruiser.

Torpedo-cruisers.

The immediate predecessors of the torpedo-cruisers seem to have been the fast despatch-vessels which were in vogue ten to twenty years ago. The Zieten was a torpedo and despatch-vessel built by the Thames Iron Works for Germany in 1876. She was a twin-screw iron vessel of about 200 feet and 1000 tons, with a long, low hull, and bow and stern torpedo-tubes six feet under water. The designed speed was 16 knots. She carried lately 10 machine guns.

The Staffeta, built by the Italians at the same time, was 253 feet long and displaced 1388 tons. Her speed was 14 knots. She had one torpedo-tube, four 12-centimeter guns and a number of smaller ones.

The German Blitz and Pfeil, 1882, were much the same. They were twin-screw steel vessels of 246 feet and 1382 tons. Their maximum speed was 16.3 knots. Their armament was one submerged tube, besides rapid-fire and machine guns.

The Alacrity and Surprise, built by the Palmers for the English government in 1885, were purely despatch-vessels, but they gave by their lightness and speed a suggestion of possible torpedo use. They were twin-screw steel vessels of 250 feet and 1600 to 1700 tons. They made upwards of 17 knots with forced draught. The Alacrity was armed with ten 6-pounders and two machine guns. It will be seen how opinion is reverting to this style of armament for vessels of this type to the exclusion of torpedoes.

Next came the English Curlew and Landrail in 1885-6. They came very near the eventual torpedo-cruiser, but they were too small and too slow. They were twin-screw steel vessels of 195 feet and 950 tons, with a speed of 14½ knots. Their armament was a number of 5-inch and 6-inch breech-loaders, besides rapid-fire and machine guns, and three torpedo-tubes. Thus it is seen the torpedo is beginning to assume prominence

At the same time the Armstrongs were building the Leopard and Panther for Austria. They were 224 feet long, displaced 1530 tons, and had a speed of 18½ knots. They carried four torpedo-tubes in addition to a numerous gun armament. They were built with a high poop and forecastle for weatherly considerations and were much subdivided.

In the English Scout and Fearless, 1885-6, the typical torpedo-cruiser was reached. Subsequent steps have been retrogressive, at least as regards the torpedo features. They were about the size of the Leopard, but had scarcely more than half the horse-power. They were loaded down with both guns and torpedoes. They were 220 feet long, displaced 1580 tons, and steamed 16.7 knots. They carried originally eleven torpedo-tubes, one of which, in the bow, was submerged. Four have since been removed. The gun armament consisted of four 5-inch and eleven rapid-fire and machine guns. The type was intended to keep the sea in all weathers and afford comfort to the crew. They were designed as a result of the shortcomings of torpedo-boats proper, and were referred to in the prints of the day as sea-going torpedo-boats.

The French contemporaries of these vessels were the Condor and her class, the Epervier, Faucon and Vautour. Their design really preceded the English ones, but they were longer in building. They were 217 feet long, displaced 1240 tons and made nearly 18 knots. Their armament was five torpedo-tubes, and five 10-centimeter guns, besides rapid-fire and machine guns. The upper deck was turtle-backed the whole length; there was a 1½-inch steel deck, a splinter deck, a double bottom, and a cellular water-line belt. They had compound engines and four locomotive boilers.

A number of other vessels of this type followed in different countries, but it is not necessary to describe them here. Particulars of some of them are given in the tables. The English Archer, a slightly enlarged and modified Scout, and the American copy, the Yorktown, exemplified the type in the essential features. The German Greif (1886) and the Italian Coatit (1896) are the fastest of any of them, having been designed for 23 knots.

This class of vessels, as torpedo-cruisers proper, have not proved a success. They were intended to chase and destroy torpedo-boats, as well as to engage large ships with their torpe-

does. They were loaded with guns, men, torpedoes and machinery. The fastest of them can catch torpedo-boats proper in deep water and in a sea-way, but they cannot follow them into shoal water. It is hard to understand in what way they were intended to use their torpedoes. They are too large to make a surprise attack. They have guns heavy enough to engage much larger and heavier vessels, but they would not dare to come near enough to use them. Stripped of their heavy guns and torpedoes, they would make very efficient scouts, especially the later and faster ones. They could carry a very numerous armament of medium-weight and light rapid-fire guns. In France this re-armament is already taking place, and markedly in the class of torpedo-gunboats, as we shall see later.

Torpedo-Gunboats.

In the early days of the torpedo, the generic title of vessels expressly fitted for its use was torpedo-vessel or torpedo-ship. As the type developed, differences began to appear. Several comparatively slow vessels of various sizes retained the original name. Some of them have been described. The larger ones of moderate speed were known eventually as torpedo-cruisers, with an intermediate stage of despatch-vessels, as has been shown; and the smaller ones came to be called torpedo-catchers, and finally torpedo-gunboats.

The eventual French names of the various types, in order of size, may be given here as follows: *Croiseurs-torpilleurs, avisos-torpilleurs, éclaireurs-torpilleurs, torpilleurs de haute mer, torpilleurs-garde-côtes, torpilleurs-vedettes.*

The Austrians were the first in the field with gunboats by several years. Their Spalato and Zara, dating from 1879, were twin-screw steel vessels of 180 feet and 840 tons, with a speed of 14 knots. Their armament was a number of small caliber breech-loaders and machine guns, and two torpedo-tubes. They had a protective deck and high-speed compound engines supplied by locomotive boilers. In these regards they marked a decided advance in construction, but the speed was a disappointment.

The Sebenico (1882) and the Lussin (1883) were of the same displacement, but were slightly longer. The speed was the same. The Lussin had two 6-inch guns, besides smaller ones, and two torpedo-tubes.

The French Bombe class (1885-6) were, however, the pioneers of the typical torpedo-gunboat. The duties of this type may be summarized as follows from the Annual of the Office of Naval Intelligence, 1891, page 415: The tactical use of the torpedo-gunboat is to destroy torpedo-boats before the latter can reach the ironclads of the fleet; to cruise inside the blockading fleet and to give warning of the enemy's movements; cruising with the fleet to act as scouts, engage similar vessels, support torpedo-boat flotillas; to attack the enemy's squadron at night or force a blockade; and to undertake the duties of a high-sea torpedo-boat.

The Bombe class were twin-screw vessels lightly built of steel, 197 feet in length and of 395 tons displacement. Their speed was 18 knots, which was made with 2000 indicated horse-power. They were fitted with a water-line belt of cellulose. The sides were turtle-backed. The original boilers were of the locomotive type. They have been changed in the Bombe for the d'Allest. Nine water-tight compartments were fitted. The complement was 63 officers and men. The armament was two torpedo-tubes in the bow and seven rapid-fire and machine guns. The vessels were handy, but the construction proved too light. They rolled a great deal and were wet and uncomfortable.

The English Rattlesnake dates also from 1886. She was built of steel with a half-poop and forecastle. The length was 200 feet, displacement 550 tons. She made 19½ knots on 2800 indicated horse-power. The armament was four torpedo-tubes, one 4-inch breech-loader and six 3-pounders. There were four locomotive boilers. This type was adopted by the Board on Construction to obviate the difficulties due to wearing out of crews and constant breaking down of torpedo-boats. They were also intended to overhaul torpedo-boats in rough weather. Their light draught would ordinarily safeguard them against torpedoes.

Subsequent English types have been merely developments of the Rattlesnake. They were the Sharpshooter class, 1888-9; the Alarm or Jason class, 1892-3; and the Dryad or Halcyon class, 1893-4. Their details are sufficiently given in the tables.

The Italians entered the field with the Folgore and Saetta, 1886-7. They were 186 feet long, displaced 377 tons, and made 20 knots on 2000 horse-power. They had four torpedo-tubes and seven rapid-fire and machine guns.

The first four of the Tripoli class followed that year and the

next. They were noted for their triple screws. They were much larger, reaching 845 tons and 230 feet. Their armament was five torpedo-tubes, one 4.7-inch and seven other rapid-fire guns. The speed was 20 knots on 3600 horse-power. The class has been substantially reproduced to the present time, except as to the triple screws, which were not repeated. The earlier vessels were too light and vibrated excessively. This has been corrected in later ones.

In 1886-7 Messrs. J. and G. Thomson built the Destructor for Spain. She was 193 feet long and displaced 458 tons. She made from 20 to 23 knots on 3800 horse-power, according to the load. She had four cylindrical boilers and 39 water-tight compartments, with each boiler and engine in a separate compartment. She had complete coal protection and a curved 1¼-inch steel bulkhead forward. She was cut away at the ends for manœuvring and had a bow rudder. The masts were hinged to lower. The armament was five torpedo-tubes, one 9-centimetre gun, and six rapid-fire and machine guns. She, like the Wiborg, was built for head-on attack.

It is not necessary to go farther with the descriptions. The class as such has never proved satisfactory. The size has been continually increased in the endeavor to make the vessels fast, habitable and seaworthy, until the distinctive torpedo features have practically disappeared. They have never been equal to catching the best of the torpedo-boats, a duty now relegated to the destroyers. Scouting is therefore all that is left to them. By omitting their torpedoes, other qualities can be improved, such as speed, coal endurance, gun armament and ammunition.

The French have in great measure taken this view, and the order has been given to remove the torpedoes from all the class, a work now actually in progress. The boats, however, are still to be used as catchers. All of the intermediate types between cruisers and torpedo-boats are classed as *contre-torpilleurs* in the latest published lists. The more recent and fastest of them, with a numerous armament of light rapid-fire guns, should in addition make very efficient despatch vessels and scouts.

Torpedo-boat Destroyers.

The next type of vessel to be considered is the torpedo-boat destroyer. The genesis of the type has been fairly well indicated

in what precedes. The gunboats had been getting bigger and bigger, but had never been able to accomplish the object of their design, *i. e.* to catch torpedo-boats. It was decided, therefore, to build a big torpedo-boat, with plenty of engine power, and to arm her with a large number of light guns. This departure has resulted very satisfactorily. Although the destroyer was designed primarily to accompany the fleet and guard it from torpedo-boats, it was soon seen that as a high-sea torpedo-boat itself, with a moderate armament of both guns and torpedoes, it was the logical solution of the very difficult requirements of the case. This curious feature is touched on at more length in another place. The name has been retained to designate the type, but it now only partially indicates the use to which such vessels may be put. High-sea torpedo-boat would perhaps be a better designation; for it is a very good rule that any boat should have a sufficient gun armament, in addition to her torpedoes, to engage vessels of her own size and to destroy any smaller ones, which would in fact constitute her a destroyer.

The Havock, the first of the type, was built by Yarrow in 1893. She was 180 feet long, displaced 220 tons, and steamed 26.8 knots on 3500 indicated horse-power. She had three torpedo-tubes, one in the bow and two on a turn-table on deck. The gun armament was one 12-pounder on the conning-tower and three 6-pounders distributed on deck. The lines of the vessel had all the characteristics of the torpedo-boat, such as light draught, full body, sharp bow and full stern, all on an enlarged scale. Forward was a high turtle-back extending to the after side of the conning-tower. She was divided transversely by thirteen bulkheads, and there were twenty water-tight compartments in all. The conning-tower was of ½-inch steel plates. The Havock's boilers were of the locomotive type, though her sister-boat, the Hornet, had tubulous boilers.

It is not intended to describe all of these boats. The size has increased to 210 feet and 300 tons, and the horse-power to 6000 or over, designed to give a speed of 30 to 32 knots. Some mention may be made of two or three of the most recent. The Sokol was built by Yarrow for Russia in 1895. Nickel steel was employed to lighten her construction. She is 190 feet long, of 240 tons displacement, and was guaranteed to make 29 knots on 4000 horse-power. She has triple-expansion engines and Yar-

row's straight-tube boilers. The armament is two single deck tubes for 16-inch torpedoes, one 12-pounder and three 6-pounders. On her official trial, with 30 tons load, she made 29.76 knots for three hours on 3700 horse-power with an expenditure of 2.1 pounds of coal per horse-power per hour. She made 30.28 on the measured mile with 4490 horse-power, the then fastest speed.

The Desperate has just been built by Thornycroft. She is 210 feet long and displaces 272 tons. She made 30½ knots on 5600 horse-power with a coal consumption of 2.49 pounds per horse-power. The load carried was 35 tons. She broke a crosshead last June, wrecking the cylinder and scalding a number of men. She was running at 30 knots and carrying 210 pounds of steam. Our No. 11 is an essential copy of this boat, and is to make 30 knots with the same trial load, that is, 35 tons.

A departure has been made by Yarrow in four boats for the Argentine, now about completed, of which the Santa Fé is the first. They are protected by ½-inch steel armor completely surrounding the engines and boilers. The speed is 26½ knots, which means a sacrifice of three knots or more as compared with the Sokol, a vessel of practically the same size by the same firm.

This question of armor for large torpedo-boats, while advocated by some authorities, is not generally regarded with favor. The thickness of the armor is scarcely sufficient to be of much protection in an attack on a battleship or large cruiser. Surprise is here the best defense; and if this is effected, armor will not be required. In an engagement with other boats, armor might be of service, but hardly at the sacrifice of speed. An important duty of these boats is to protect the fleet from torpedo-boats. Should they fail in this through insufficient speed, the armor would be worse than useless. Taken altogether, if there is any weight that can be spared after the requisite speed and coal endurance are secured, the best place to utilize it would seem to be in added guns and ammunition.

The Durandal is one of Normand's latest boats. She is 180 feet long and displaces 300 tons. She is to make 26 knots with a load of 85 tons, representing armament, ammunition, crew, equipment, coal, and stores. The armament is two torpedo-tubes on the central line, one 9-pounder, and six 3-pounders. The full bunker capacity is 100 tons. A peculiar feature of the boat is a flying grating deck, extending from the conning-tower

to within 30 feet of the stern, on which the torpedoes and guns are worked. In this boat M. Normand has remedied many of the defects noticed in the Forban type. If she meets expectations, she should prove very effective. As will be seen later, she comes very near a type that is recommended for use in our own service.

Lord Brassey, in the Annual for 1896, page 194, quotes a naval officer present at the 1895 manœuvres of the torpedo squadron as follows:

"The impression left in my mind by the manœuvres was that all the present types of torpedo-boats are obsolete, and that probably no more will ever be built. But I believe that boats of the size of the destroyers will take their place in every navy, and that a competition as regards the numbers owned will begin."

A New Steering Device for Torpedoes.

One of the most important of the recent improvements in torpedoes, some mention of which has been made in another place, is a device for keeping the axis during the run always in the direction it had at the instant of launching. This has been accomplished both in Austria and Germany. The principle in both devices is that of a freely suspended gyroscope, which is used to bring the torpedo into its original direction through the agency of an air engine actuating a vertical rudder. The details, however, as indicated by the patent specifications, are quite different. From authentic accounts, the results of practice have been remarkable. The torpedo may be launched in any kind of weather, in any direction, from a torpedo-boat at its maximum speed by simply pointing the tube at the target. Although the torpedo is deflected as usual, the gyroscope at once brings it back to its original direction with only the error due to the short time it was off its course.

This principle is not new, as it has long been used in the Howell torpedo, but with the difference that in that torpedo the axis of the gyroscope is rigid. It, therefore, resists change of direction; but when the change has taken place, as on deflection when launched from the broadside at speed, it will not bring the torpedo back.

With the new device, the practice at a fixed target appears to be accurate even up to a range of 2000 yards. The ordinary

working range will be easily extended beyond 1000 yards. It will always be difficult to make hits on a moving target, but it is a great gain to be able to eliminate the uncertainties of the initial deflection, hitherto the most serious drawback to accurate practice.

If it is found that the reports so far received continue to be borne out by results, it will be necessary to revise the tactics of ships as well as of boats. The value of the torpedo becomes greater than ever before, and the need of suitable torpedo-craft increases correspondingly.

Search-Lights in Torpedo Boats.

Some of the larger torpedo-boats and destroyers are equipped with search-lights. Their utility is open to doubt. The purpose for which they are carried is to light up torpedo-boats that may be discovered and make better marks of them for the guns. At high speeds or in a sea-way, it is doubtful if a search-light can be kept on as small an object as a torpedo-boat with sufficient steadiness to make her a good target. Steady platforms are adopted for the lights in some boats, but in the absence of experience with the fittings, I doubt if they entirely overcome the difficulty. The principle is again that of the gyroscope. The relative motion of the boat with reference to the plane of the gyroscope is utilized to actuate hydraulic motors in the proper sense to keep the platform steady.

The great drawback to the search-light is that there is no concealment for the boat carrying it as soon as it is turned on, and it gradually blinds the eyes of the lookouts. Boats which would certainly be seen were the lights not used might easily get by if they happened to avoid the beam. It would appear to be better to trust to good eyesight and good lookouts to pick up the quarry; then by superior speed to stick to him until he was put out of action, aiming in the meantime as well as previous training and the circumstances would permit.

Torpedo-Defense-Nets.

The day of the defense-net is apparently passed. The objections are that they are cumbersome, hard to get in and out, cannot be carried underway except on the broadside, and then only at a greatly reduced speed, are dangerous in action from

the liability to foul the propellers, could certainly not be used after an action, and might, on occasions when rigged out, prove a source of great embarrassment, due to the delay incident to getting them in.

Moreover, it was found that various devices could be fitted to the heads of torpedoes to cut through the nets. The weight was increased to the limit of practicability and all to no purpose. Ships now building are not being fitted with them. France, Russia and Austria, I believe, have definitely abandoned them, and opinion in other countries is decidedly adverse. The United States has never adopted them. This points to the necessity of considering other means for the defense of ships against torpedo-boats.

Attacks under the Search-Light.

I purpose under this heading to examine some of the conditions under which torpedo-boat attacks may take place. The kind indicated is most generally associated with the use of torpedo-boats. As will be seen later, however, the search-light, except to a very circumscribed extent, is not recommended as a form of defense.

I will take it as established that the attack must be at least partially a surprise. With the modern batteries of rapid-fire and automatic or semi-automatic torpedo-guns, it will be impossible for the torpedo-boat to exist for more than a very limited time if she is discovered before reaching torpedo range. What that time is may well be open to discussion. It will depend on the atmospheric conditions, the amount of light on the boat, the speed of the boat, the state of the sea, the number and character of the guns that can be brought to bear, and the expertness of the gunners. The boat then must try and get as near as possible before she is discovered at all, and the ship must find a way to discover and destroy the boat before the torpedoes can be launched.

With the present development of the automobile torpedo as a weapon of war, 500 yards is the admitted effective range. Reference has been made in another place to an apparatus for steering torpedoes that seems certainly destined to revolutionize ideas in this regard, but for the present it is not considered. Now as to the best means at the disposal of the offense to bring its

weapon to this range of 500 yards and of the defense to prevent it. The smaller and more invisible the boat, the darker the night, the greater the absence of noise, as from the blowers, of flame from the funnels, or of disturbed water at the bow and stern, the less will be the chance of discovery, either by the ship or by her destroyers or vedettes, with or without the assistance of search-lights. Speed would be of advantage in taking the boat more quickly through a zone in which there might be danger of discovery, but if at the expense of noise, or flame, or water disturbance, the gain would be questionable.

The ship attacked may be either at anchor or underway. If at anchor, the means of defense consist of obstructions, such as chains and booms, torpedo-boat destroyers cruising about the harbor entrance, vedette-boats and pickets distributed on inner lines, and fixed beams of light illuminating zones across which attacking boats must pass. The search-light used in any other manner is condemned by all the best authorities. It affords a mark for the attack, and it gradually blinds the eyes of the watchers. When the boats are discovered, the lights should be turned on them for the benefit of the gunners; and this and the other are apparently the only logical uses of the search-light. The fixed beams, above referred to, can be thrown from stations ashore or from special vessels other than those expecting the attack. The use of booms and obstructions will depend much on the locality and the time at the disposal of the defenders. Destroyers, vedettes and pickets, could or should be available under almost all circumstances. Defense-nets are not here mentioned, as they are considered undesirable, for the reasons before given.

If the ships are cruising, the best defense is to screen all lights, assume a formation compact enough to permit each ship to be visible from her neighbor, and to dispose the scouts, cruisers, destroyers, and torpedo-boats, should any of the latter be present, in such wise as to make it improbable that the enemy's boats shall break through to the larger ships.

In support of the arguments as to the use of the search-light, data from the Torpedo Station records will be of interest. In twenty-six different exercises that have taken place between the torpedo-boats stationed there and search-lights ashore, or in ships of the navy afloat, the average distance of discovery by the

aid of the light was 781 yards; the greatest distance 2000 yards; and the least, practically zero, the boat having got alongside the ship without discovery. The weather during these exercises was generally good, never with any appreciable fog or mist, and occasionally with a full moon.

Other sets of figures were obtained by causing the boats to run out under the search-light to the limit of visibility. The distances under these circumstances varied from 1000 to 2750 yards. The difference is due to the great difficulty of picking up a small neutral-tinted object by a sweeping beam.

Now taking the average distance of discovery, as above stated, at 781 yards, in order to reach torpedo range of 500 yards, the boat must cross a zone of 281 yards, which at the moderate torpedo-boat speed of 20 knots would require 25 seconds. Is this sufficient to put the boat out of action? If not, the chances of a single boat against a single ship depending only on search-lights would be more than one-half. With several boats, making a preconcerted attack, the chances of the ship would be correspondingly less.

It may be stated that in all the exercises referred to no advantage was taken of cover, such as might have been afforded by vessels at anchor or outlying islands. In making an attack, the boats always kept in visible range of the search-lights within a radius of 2000 yards.

It is to be regretted that we have no definite data on which to base a conclusion as to the time that would be required to disable or destroy an attacking torpedo-boat. Foreign practice in the annual manœuvres has limited the time from three to one minute, the tendency having been gradually to reduce it. The Torpedo Station rules have required an interval of two minutes outside of 400 yards, equivalent to one minute and 48 seconds outside of 500 yards at the speed ordinarily used.

Abroad, the attacking boat has been required actually to make a hit with a dummy-head in order to score a success; but with regard to the time necessary to ensure the destruction of the boat, everything was surmise, an arbitrary rule governing. I understand that Captain Evans, of the Indiana, has suggested an experiment at towing a light target representing the cross-section of a torpedo-boat at the end of a steel wire 1500 yards long directly towards the ship expecting an attack. The towing

vessel could be one of the fast torpedo-boats now approaching completion. She would steam directly towards the ship at her highest speed under the conditions, the ship to turn her search-lights on the target and open fire the instant the torpedo-boat passed clear on the off side. The fire would be continued until the target was estimated to be at torpedo range, after which the hits would be counted. The line could then be shortened to reduce the interval of time under fire, and the experiment be repeated. Eventually there would be some very satisfactory data connecting speed, distance, time, number and character of guns, and number of hits.

From what I have seen of somewhat similar experiments in former years, except that the target was at rest, I am under the impression that in 25 seconds, the average time of reaching torpedo range from the probable distance of discovery, as determined by the Torpedo Station experiments, the torpedo-boat would not be found to be *hors de combat.* If the working range of the torpedo is materially increased by the new automatic steering device, all the arguments as above acquire added weight in proportion.

The rational defense of the ship, then, whether at anchor or underway, seems to be the scout, the torpedo-boat destroyer, the torpedo-boat, the vedette-launch, and the picket-boat. Our types of boats, then, would logically include all of the above, and, if possible, a boat adapted to evade them all. Here, perhaps, is the field for the submarine boat. This, however, opens a wide subject in itself. The essay is confined to surface boats.

Deductions.

The various types of vessels in which torpedoes are or have been the principal arm have now been passed in review, and some of the conditions governing their use have been examined. The present tendency of opinion, as has been shown, opposes the farther development of some of them. Taking up the types in order, the conclusions that appear to be justified as regards future permissible locations of torpedoes are somewhat as follows:

The unprotected torpedo is a surprise weapon. In battleships and large cruisers, surprise is not attempted; but protection for the torpedo may be found behind armor or in sub-

merged positions. The protection that is deemed necessary is not to prevent explosion of the war-head, which careful experiment has shown to be a very remote contingency, but is rather to prevent destruction of the tube and mount, or explosion of the air-flask, as the result of gun-fire, before the vessel reaches torpedo range.

The only remaining questions as regards these ships are as to the numbers of tubes and their location, whether above or below water. These questions will be decided more by structural considerations and future developments of the torpedo in accuracy and ease of handling as regards over- and under-water fire. There can be little doubt that the torpedo is a desirable weapon for such ships. It has been opposed frequently on the score of its lack of reliability and the supposed danger to its users and their friends, which was regarded as comparable in degree to its menace to the enemy. Improvements in the speed, range and accuracy of the torpedo, and in the safety of handling, must counteract such of this opposition as does not spring from lack of knowledge of the weapon.

In the case of torpedo-cruisers, the justification for the presence of torpedoes at all seems to have quite disappeared. These vessels are too big to effect a surprise in any conditions of weather, and they afford no protection to the torpedoes. On discovery by a larger vessel, their only safety lies in flight. Nor are they of any use against torpedo-boats. By reason of their size they are likely to be discovered themselves before they sight the boats, a circumstance which, taken in conjunction with their lack of speed, makes the capture or destruction of the boats quite improbable.

By omitting the torpedoes and heavy guns and carrying in their place a numerous and light gun armament, and making the speed as high as the changed armament will permit, there is secured a very effective scout and lookout vessel. This is decidedly the tendency of opinion abroad to-day, and the probabilities are that in the not distant future the torpedoes will have been wholly withdrawn from the type.

Passing on to the torpedo-gunboat, or torpedo-catcher, as they are still often called, much the same reasoning obtains. This class has had a varied career from vessels of the size of the Austrian Meteor of 350 tons to the English Dryad or Halcyon

of 1070. As we have seen, they are all unsatisfactory as designed. By removing their torpedoes and arming them entirely with light guns, they may be given a higher speed and thus be used as scouts and to assist the destroyers in keeping off the enemy's torpedo-boats. It is probable that the smaller ones will not be produced in the future. From the large cruiser to the present torpedo-boat destroyer, it is doubtful if there is any use for more than one type—a very fast gunboat of about 1000 tons, with a very numerous armament of medium and light rapid-fire guns and no torpedoes.

This brings us to the torpedo-boat destroyer and the torpedo-boat proper, which are now quite generally regarded as the only possible types of special torpedo craft. But when it comes to the essential features of these two types, opinions are very divergent, often, I think, due to varying conceptions of the duties of the boats in question.

This is instanced in the recent contracts for the 30-knot boats. The designs were here left to the builders. Nos. 9 and 10 as authorized are to be of 146 tons, while No. 11 is to be of 273 tons. These are odd results to follow from one clause of an appropriation act, designed to secure three essentially similar boats to carry the same armament and make the same speed. It is hard to see how the contractors for Nos. 9 and 10 are to fulfil the remaining requirements of equipment and coal supply, features in which the prototypes of these boats, as has been seen, are exceptionally deficient.

Nor would it seem to be possible that a satisfactory boat could be designed by the collective bureaus of the Navy Department that have to do with *matériel*, for the sole reason that the requirements of armament, equipment and machinery are all antagonistic to each other and to those of total displacement. If a board will first decide exactly to what use the boat is to be put, and what armament, speed, coal endurance and crew she will require for such use, then the displacement and horse-power will follow naturally. All the features will then be settled, and each bureau can have full swing in its own domain. If builders compete on their own designs, they also must use their skill within the limits of the settled requirements. If any other method is adopted in producing these boats, then when they are finished it will have to be determined what can be done with them.

I submit the following as some of the uses for which in our own case torpedo-boats will be required. I shall not say that these are the correct uses or all the uses; but the assumptions will at least lead to definite types of boats.

In the first place, boats, and a good many of them, will be needed for the defense of our seaports, and to operate for limited periods with the squadron near their own bases, where they can seek refuge in bad weather, leaving the Admiral entirely free of care in their regard, and can renew their supplies. These boats would be used also for massing at threatened points by means of our unrivaled inland-water communications.

Their purpose is to destroy the enemy's ships. This must be done by surprising him at night or in a fog. I leave out for a moment the case in which they attack from the lee of a battle-ship in action, or from a point near the scene of action, as opportunity offers. For a surprise attack at night, or in a fog, the boats should be as small as consistent with other considerations, otherwise the feature of invisibility is sacrificed. The weapon should be the equivalent of the long 18-inch Whitehead torpedo, with a speed of at least 28 knots at 800 yards and an explosive charge of 220 pounds of gun-cotton. The next smaller type sacrifices perhaps 50 per cent. of the destructive power and accuracy and reduces the value of the boat to a corresponding extent. Two at least of the torpedoes selected should be carried in central pivot training tubes on the deck of the boat, and one or more should be carried in reserve.

All torpedo-boats carry gun armaments with which to engage other boats, either for the purpose of proceeding on the intended mission or for turning back the enemy. A safe rule is to carry no less than the average armament of boats of the same size in any other service, and more if other considerations will permit. Some foreign boats carry four 3-pounders, and this is better than the average. It is a desirable armament for the purposes indicated. The automatic type of gun would be preferable should the system be found to be reliable in service. Guns of smaller caliber than 3-pounders are of little use, as it has been shown that they will not perforate the filled coal-bunkers of the ordinary torpedo-boat.

While on this subject of torpedo-boat engagements, it may be stated, as has been mentioned before, that ramming has often

been recommended as a quick method of settling matters if an opportunity is afforded. If a boat or vedette can be surprised and rammed before much alarm is given, it will be a decided gain. To do this a safe rule would be to strengthen the bow of each boat to permit her to ram her own equivalent or any smaller boat. Here at once we are met by the objection that fast, handy boats cannot be turned into rams without the sacrifice of speed, that they should be built for one purpose only, and if too much is attempted, all fails.

This is a very strong argument. The only point to consider in each case when it is a question of adding some new weight is this:—is speed everything; how much speed will be sacrificed by adding this weight, and will the advantage pay for the sacrifice? To strengthen the bow of a torpedo-boat to ram one of its like or any smaller boat will require, it is estimated, 5 to 10 pounds for every ton of displacement, or for a boat of 120 tons, 600 to 1200 pounds. This would be disposed in the form of internal strengthening plates, longitudinals, and transverse braces. The loss of speed in a boat of this size per ton of added weight is estimated to be one-tenth of a knot. The weight proposed would therefore diminish the speed of the boat by the twentieth part of a knot.

While it is not claimed that the bow of a torpedo-boat thus strengthened would be absolutely uninjured by ramming, it is believed that the object would be attained without material damage. Incidentally, the boat could cut through several inches of ice without the least injury, a feature which in winter might prove of the greatest value in some of our northern ports and in the canals.

The ram form of bow is not advocated. The straight stem offers better sea-qualities and it can be made to cut as effectively as may be required. The writer saw the Richard Peck, a Long Island Sound steamer, with a straight stem, cut a tug in two halves without any apparent injury to herself. During the French manœuvres last summer, the Audacieux, a sister of the Agile, a boat the size of our Cushing, collided accidentally with the Chevalier, striking her on the side. The Audacieux's bow was wrecked, and the collision bulkhead did not stop the entrance of the water, resulting in the loss of the boat. The Chevalier had her side protected by an angle belt of steel with a wood backing, and though injured, was kept afloat. This

points to the need of more strength in the bow, whatever conclusion may be drawn as to that required on the side.

The elements of size, speed, coal endurance, and sea-keeping qualities are to a great extent interdependent. We have seen that the size cannot with advantage be great, or the boat would be too readily discovered on a surprise attack. This in itself limits the other qualities. Now the coal endurance and sea-qualities need not be greatly developed for the purposes set forth, especially the latter. When the weather is too bad for a boat of say 120 tons to remain at sea, it is too bad to launch torpedoes, and she may as well seek shelter.

It is somewhat different with the coal supply, as it might be necessary to return to port to coal at a very critical moment. Therefore the coal endurance, while not necessarily as great as for a sea-going boat, should not be unduly sacrificed. A week's continuous steaming at squadron speed, equivalent to 18 hours at full speed, is about the lowest point at which the endurance can well be placed. Of the boats quoted in the tables, the average endurance at 2 pounds per indicated horse-power per hour, is between 18 and 19 hours. This endurance can readily be obtained in a boat of 120 tons, provided excessive speed is not attempted, and still an ample margin be left for the guns and torpedoes as recommended.

In this connection may be mentioned the great confusion associated with the term "normal displacement." As understood by builders, it means enough coal for the trial and as many other weights omitted as the government will permit. A rational definition of normal displacement is the displacement with all the ordnance and equipment weights aboard, the crew and their effects, and half the coal, provisions and stores that would be carried when fully loaded for sea. If it was understood that trials were to be conducted with such weights aboard as would cause the mean trial displacement to be the normal displacement as above defined, the whole question would be manifestly simplified.

As regards speed, there will be many divergent opinions. On general principles, speed is good, and it should be as high as possible. When it comes to sacrificing torpedoes, or guns, or the power to ram, or coal endurance, or involves a much increased size, then a very careful consideration should be given the relative values of the different qualities. Now what are the

objects of speed? The first answer is, to get up to the enemy as quickly as possible after discovery, in order that he may not destroy you by gun-fire, and to get away from him quickly for the same reason; secondly, to be able to strike unexpectedly from a distance in a brief time; thirdly, to avoid the enemy's destroyers.

In the first case suppose that 22½ and 30 knots are two speeds to be compared. 1500 yards is a long distance at which to discover a torpedo-boat if the night is at all suited for an attack. At 500 yards the boat can discharge her torpedoes. The time in passing from 1500 to 500 yards is, for the lower speed, 1 minute and 20 seconds, and for the higher speed 1 minute. Other things being equal, the 30-knot boat will be larger and can be seen farther, and will afford a better target to the guns, which will cause even this difference to vanish. If coal endurance has been sacrificed to accomplish speed, the sacrifice will be immense, and for how small an advantage! Moreover, torpedoes, as at present fitted, cannot be launched with accuracy at either of the above speeds. The boats will have to be slowed materially on reaching the range. Then, too, prior to discovery, it will not be advisable to steam at more than 12 knots, to avoid water disturbance and flame at the funnels. When the time for working up to full speed after discovery, and then reducing to allow of accurate torpedo discharge is considered, there will be a very inappreciable difference in the two boats. In fact the high speed boat will not have time to work up to full speed, and the slower boat may arrive as soon. This argument may be modified to a certain extent by the new device that will permit torpedoes to be launched with accuracy at any speed. But when we consider that a boat discovered at 1500 yards is in all probability a boat lost, if she attempts the attack, and that success depends on getting pretty close to torpedo range without discovery at all, the argument in favor of the 30-knotter as opposed to the boat of 22½ knots is reduced to practically nothing. All the above to be understood to apply to the case of the boat operating from a shore base, or with the squadron on its own coast for limited periods.

As to being able to strike quickly from a distance, of course the higher the speed, the better; but the difference between 30 knots and 22½ does not warrant the very considerable sacrifice of other qualities for this purpose alone.

Now as to avoiding the destroyers in the enemy's fleet. Here is the only approach to an argument for the higher speed. If you can arrange that a torpedo-boat of average size with high speed and no coal endurance shall start from port and find the enemy without delay, she may with her speed get past the enemy's destroyers should they sight her, provided the weather is perfectly calm. With any sea on, the larger boats will soon run her down. Then she must not lose any time in finding the enemy, or her coal will be gone. It must not be lost sight of that this speed of 30 knots or more in a comparatively small boat is attained by sacrificing either coal, stores, or armament. No, it looks as if the way to get past the enemy's destroyers was to have a larger number of ordinary first-class boats, select a dark night and make a concerted attack. Some of the boats will be lost, but some will probably get in; and a ship or two of the enemy will make up for losses.

As to the best type of boat, therefore, for the purpose designated, and in view of the reasoning as above stated, there is apparently little question that a boat of 150 feet and 120 tons would fulfil all the requirements; in other words, a boat of the size of the Ericsson. Her contract speed is 24 knots, which is high enough; but which could be exceeded now on the same weights. She carries 40 tons of coal, sufficient for a day at full speed and a week or more at 10 knots. The armament could be improved by giving her four 3-pounders instead of three 1-pounders, and two 18-inch torpedo-tubes for long torpedoes instead of the present three tubes for short torpedoes; the tubes to be mounted on the central line with train on either beam. The number of torpedoes could remain four, as at present, or two for each tube. The difference in weight, allowing 200 rounds of ammunition for each gun, would be 5.2 tons, of which less than half a ton is due to the change of torpedoes and tubes. This weight could be taken from the coal capacity, reducing the endurance by 3½ hours; as could also 1200 pounds to fit her bow for ramming, involving a further reduction of the endurance by 20 minutes; but leaving it still over 20 hours.*

* The weights on which this calculation is based are as follows :—

Short 18-inch, torpedo 850 pounds, tube 1,100 pounds, mount 300 pounds.
Long 18-inch, " 1,100 " " 1,500 " " 600 "
1-pounder, gun and mount 455 pounds, 200 rounds amm. boxed, 390 "
3- " " " 1,610 " " " " " 1,675 "

If these boats were intended in special cases never to leave the neighborhood of their own bases, a better arrangement of the torpedoes would be to omit one torpedo and install a third tube, thus carrying three torpedoes, one in each tube. The boats would replenish their torpedoes at their bases, as required. This would involve an additional weight of 1000 pounds, which would not be prohibitive.

The next purpose to consider for which boats may be required is to accompany the fleet for indefinite periods. They may be intended to destroy the enemy's torpedo-boats or to act against his ships. For the last-named purpose the type just described would be most appropriate were it not that the endurance and sea-keeping qualities are both deficient. Near their own bases, as before shown, they may be of the greatest value. But to ensure endurance and sea qualities it is necessary to pass at once to double the displacement at least. Invisibility has to be sacrificed to ensure this ability to keep the sea with the fleet in all weathers. But granting a certain sacrifice of invisibility, it is not desirable to dispense with that quality altogether. A displacement of 250 to 300 tons can be made to produce a seaworthy boat, though perhaps not always a comfortable one. Then it is of a size that does not entirely preclude the possibility of a surprise attack on a suitable night. With this displacement it is possible to attain a satisfactory coal endurance, and in addition to increase the speed by several knots.

According to Froude's investigations, as instanced by Mr. Thornycroft in a lecture before the Royal United Service Institution in May, 1895, it is at this point that speed is more economically attained than at other displacements short of several thousand tons. This reason, and the objection to a further sacrifice of invisibility, and the desirableness of not increasing the draught beyond the requirements of shoal-water navigation, all tend to prevent a further increase of displacement. Moreover, with us, this limit is imperatively set by the dimensions of canal locks.

The argument against intermediate sizes is that for use from a fixed base they are larger than necessary, as already shown. They can be given a higher speed at the sacrifice of invisibility, but this is not desirable. For continuous use with the fleet they are not large enough to offer that guaranty of comfort and seaworthiness

in all weathers deemed to be essential to the effectiveness of the crew.

With regard to the armament of these boats, the conditions already laid down make it possible to combine two objects. It was stated that the boats with the fleet were intended for use against ships or torpedo-boats. Now in the type arrived at, the considerations contemplated the first use only. But after giving the boats three torpedo-tubes, which is all they require (the recent English destroyers have two), there is still a margin of weight that can be applied to a very effective gun armament. Moreover, their high speed enables them easily to overhaul boats of the smaller type. Hence this large type is logically capable of both uses, or of any use to which boats with the squadron may be put; either to destroy the enemy's ships when opportunity offers, or to defend the squadron against the enemy's torpedo-boats.

It is curious to notice that the actual differentiation of this type, destroyers as they are called, was quite different. They were built originally to catch torpedo-boats. They were to be large enough and have speed enough to overtake torpedo-boats in rough or smooth water, and were to be able to follow them into shoal water. They were to carry a powerful gun armament, sufficient to destroy any torpedo-boat. At first even it was not contemplated to give them torpedoes. But as they would then have been harmless against large ships, and would have had no weapon with which to defend themselves, it was decided to arm them with a few torpedoes also. It has been shown that they are able to carry both guns and torpedoes. After several years' experience with the type, it appears that they are just what is required for general use with the fleet. Thus, more or less by accident, a type has been developed which a logical consideration of the requirements indicates to be the only one admissible.

The armament of the latest English destroyers is two torpedo-tubes for the long 18-inch Whitehead, one 12-pounder rapid-fire gun, and five 6-pounders. Spare torpedoes are also carried. I believe these boats would suit our purposes better were another tube added, and the gun armament changed to eight 3-pounders. The boat would then go into action with three torpedoes ready for launching, and with a light and numerous homogeneous battery of rapid-firers. The automatic type of gun is to be pre-

ferred. The weight saved by this change I estimate to be two tons, a part of which could go to supplying enough torpedoes to make two for each tube, and the rest to extra ammunition for the 3-pounders.

As to other types of torpedo-boats than those heretofore considered, it has been shown that a farther increase of size is not permissible. Can a smaller type than either of the above ever be of use? It may be answered that with all the conditions favorable, smaller boats may sometimes make successes. But in view of the great limitations to their use, it is not the part of policy to include them as standards of type. There may be limiting considerations of draught of water and length of canal locks that will determine a type of boat, in which case the limitations have to be observed. Ordinarily the power of offense, sea qualities, coal endurance and speed would be reduced to a point that would result in an unsatisfactory boat.

Much has been written in regard to the place of the torpedo-boat in a fleet action. It has been assumed in the present essay that the squadron on its own coast would be attended by both torpedo-boats and destroyers. In case it is found desirable to employ torpedo-boats in an action at sea, are the two types recommended suitable for such use, or should there be still a third type for this purpose alone? The only methods that have been much advocated are for the boats to keep in the line, each one on the off side of a battleship; or for them to haul out at the beginning of the action and watch a chance to fall on a partially disabled or otherwise occupied enemy.

In the first case the boats should be small and handy, ready to dart out at any moment to take advantage of smoke, should there be any, or such cover as their own or disabled ships of the enemy might offer. In the second case speed would be the great desideratum. Two or three boats might strike suddenly at an enemy that had been compelled to leave the line, either temporarily or permanently. Here, also, boats would be required to act on the defensive and protect disabled ships of their own line from the attacks of the enemy's boats.

Although it has sometimes been advocated that torpedo-boats should make concerted attacks on the enemy's line by day, prior to beginning an action, I cannot conceive of such an attack by a sane commander, except in case of fog or mist, which would liken the conditions to those of night-time.

For any of the above uses, torpedo-boats and destroyers of the types already recommended would seem to be the choice in preference to other possible types. In fact the determining requirements of armament, invisibility, sea qualities, speed, and endurance are precisely the same, and would therefore in natural course produce the same results.

As to second-class torpedo-boats for carrying on shipboard, the weight of opinion is not in favor of them. There might be circumstances in which they could be lowered and sent against the ships of an enemy at anchor and near-by, or in fine weather when about to pass a known point. But it is not to be supposed that the enemy will be unprovided with torpedo-boats or destroyers, which would make quick work of the second-class boats. Again, should the weather come on bad while the boats were away, they would be a great source of uneasiness to the squadron. In a fleet action they would be shot to pieces if left in their cradles, and if the weather was bad it would be equally unsafe to lower them. Then, too, if the fleet is properly provided with torpedo-boat destroyers when cruising at a distance, and with first-class boats when near home ports, the second-class boats will not be required.

There seems to be a need, however, of a sufficiently large and fast ship's boat to act as a vedette. The larger ships could carry one or two of them. With the squadron at anchor in striking distance of the enemy's torpedo-boats, these vedette-launches would form a line of defense inside the torpedo-boats and destroyers. They need not carry torpedoes at all for this purpose, but would be armed with a couple of rapid-fire guns and would be well provided with signal rockets. Torpedoes in fact would be a disadvantage, as they would interfere with the gun armament. The use of torpedoes against torpedo-boats is not feasible, on account of the difficulty of hitting a fast-moving target. Also torpedoes set for ships would pass under them.

For purposes such as the above, a fast wooden launch of 50 to 60 feet, capable of steaming 17 knots and carrying two light guns, would meet all the requirements. Wood seems to withstand rough usage better than thin steel. The boats have more elasticity and can be handled with fewer precautions. They are also more easily repaired when damaged. A boat like this would be useful in many other ways aboard ship, especially when the anchorage was distant from the landing. They would have to

take their chances in an action with the other ships' boats. All would probably be lowered and left to their fate, or to be picked up by the victors.

The English fit these boats with side dropping frames for torpedoes. The frames are removable and are not ordinarily carried. This is perhaps the only feasible way of using torpedoes from ships' boats in the few cases in which they would be required. The short 18-inch torpedo, or baby Whitehead, as it was called, was originally used in these boats; but lately the long 14-inch has been substituted on account of its greater accuracy. The weight of gun-cotton in the two torpedoes is practically the same.

The internal arrangements of the boats reviewed were not described. There is a feature, however, that warrants mention, the disposition of engines and boilers as regards safety against disablement. Twin screws are desirable as a matter of course, though a number of foreign boats do not have them. They make the boat handier and lessen the chance of a complete breakdown. By disposing the engines one in advance of the other in separate water-tight compartments, and protecting them by coal-bunkers at the sides, the chances of complete disablement are much reduced. In some foreign boats the engines are side by side with no coal outboard of them, a practice certainly not to be desired. For similar reasons the boilers should be in separate compartments.

Some foreign nations, notably the Italians, have experimented for a long time with liquid fuel. There is perhaps no one feature that can be made of more value to torpedo-boats. The advantages to be gained are greater endurance for the same weight, greater facility for renewing fuel, absence of smoke, more regular steam, and less attendance. This last advantage involves a saving in weight and space that may be applied to an increase of either speed, endurance or armament on the same displacement. Added to these advantages, that we have in this country a practically unlimited supply of petroleum oils, which can be stored for use at the torpedo bases, and carried in the larger ships for the use of the torpedo-boats, that is until such time as the ships themselves are fitted to burn it, when it can be drawn from their tanks, and the argument for an early resort to liquid fuel seems unanswerable.

Since the above was written it is noted that the Secretary of the Navy in his annual report states that in consequence of the

satisfactory results of the recent trials of liquid fuel in the Maine's torpedo-launch, farther experiments are to be made in a tug now building at Norfolk and in one of the smaller boats contracted for by the Herreshoffs.

Leaving the question of torpedo-boats, there is one other type that may be briefly referred to again—the torpedo-ram. A vessel a little larger and a little faster than the Katahdin, and fitted with several submerged broadside tubes, something after the fashion of the Polyphemus, might prove a valuable adjunct to the fleet. The turtle-back upper works could be made impregnable to the projectiles of rapid-fire guns. By watching her chances and rushing in at an opportune moment, using either torpedoes or ram as circumstances indicated, she might very well score an important success.

Recapitulation.

The conclusions here arrived at may be summarized as follows:

Torpedoes are not permissible afloat except in large ships, submerged or behind armor, and in special torpedo-craft of less than 300 tons displacement.

There are only two types of torpedo-boats that seem to meet the requirements of torpedo service with the squadron at sea; and, from fixed bases, for the defense of the seaports and harbors of the coast.

The first is a high-sea torpedo-boat of 250 to 300 tons, generally similar to the present English destroyers, to mount three long 18-inch torpedo-tubes on the central fore-and-aft line, with a spare torpedo for each tube, and a homogeneous battery of eight 3-pounders, preferably of the automatic type; this boat to keep the sea with the fleet at all times and to be used either as torpedo-boat or destroyer. The speed and coal endurance are to be as high as the displacement and armament of the boat will permit.

The second type is a first-class torpedo-boat of 150 feet and 120 tons, carrying two or three torpedo-tubes according to circumstances, as previously indicated, all for the long 18-inch torpedo, and mounted on the central fore-and-aft line. In case two tubes are carried there will be a spare torpedo for each tube; if three tubes, then one torpedo only for each tube. The gun armament to be four 3-pounders. A speed of 24 knots will be

ample for this boat, and will permit of a coal endurance of at least 18 hours at full speed.

Both types should have twin screws and the engines should be in separate compartments longitudinally to minimize the risk of complete disablement, and to permit coal protection throughout the machinery space.

The bows of the boats should have sufficient strength to cut into the sides of any similar boat, or to permit running over a vedette-launch; which incidentally would enable them to cut through several inches of ice without injury, a feature of some value for inland-water navigation in the winter.

For each of the battleships and armored cruisers, it would be desirable to provide one or two wooden vedette-launches of 50 to 60 feet in length to steam 17 knots, to be armed ordinarily with two light guns, or, as an alternate on special occasions, with a smaller type of torpedo carried in removable frames.

The proportion of the two types of torpedo-boats could very well be one of the larger to two of the smaller; and that number would be a suitable proportion to each battleship and armored cruiser. These boats could be authorized at the rate of a dozen a year until the full number was reached, and thereafter it would be the part of policy to provide for a destroyer and two torpedo-boats whenever a large ship was laid down.

May it be permitted at the close of this paper to make a sentimental plea for naming instead of numbering torpedo-boats? The general practice abroad is to number the smaller boats, though this is not invariable, and usually to name the larger ones. Boats of the size of those here recommended are almost always named. I cannot think of any possible reason for not naming our boats, unless it is that if we have very many, the names may give out. That time has certainly not yet arrived. One disadvantage of numbers is that they are easily confused in orders and reports. For that reason cable codes make use of names to represent numbers.

But after all, the real reason for naming the boats is a sentimental one. If officers and men are willing to risk their lives in a torpedo attack, and honestly prefer to serve in a boat with a significant name instead of an insignificant number, their wishes ought to be considered.

Torpedo-Boats.

Name.	Date.	Builder.	Nation.	Length.	Tons.	I. H. P.	Speed.	Coal.	Lbs. per I. H. P.	Guns.	Tubes.
randa	71	Thornycroft	Yacht	50	...	....	16.2	....	..	.....	.....
sp	73	"	Norway	57	16	90	17.2	2	50	.....	.....
Boat	74	Yarrow	Argentine	55	...	65	12.5	....	..	.....	.....
imt	75	Thornycroft	Sweden	58	...	60	18	1.5	56	1 M.	1
ghtning	76	Herreshoff	U. S.	58	3	....	17.6	....	..	....	.....
tana	76	Thornycroft	Yacht	86	29	450	20.7	....	..	.....	.....
ghtning	77	"	England	84	27	460	19.4	....	..	.....	1
os. 17, 18	77	Yarrow	"	86	33	450	21	7	35	.....	2
o. 14	78	"	"	87	33	550	21.9	7	29	.....	2
veral	78	Various	France	108	45	400	19	10	56	2 1-Pd.	2
Boat	79	Herreshoff	England	60	8	...	16	...	..	.....	.....
Boats	79	Yarrow	Japan	100	40	620	20	3	11	.....	.....
o. 10	80	Thornycroft	England	90	28	450	22	....	..	.....	1
atoum	80	Yarrow	Russia	100	40	500	22	10	45	2 R. C.	2
aerdfisken	81	Thornycroft	Denmark	110	50	600	20	10	37	1 "	2
Boat	82	Yarrow	Italy	100	...	500	22.5	10	45	.....	2
Boats	82	Schichau	"	100	40	620	22	10	36	1 R. C.	2
okhum	83	Thornycroft	Russia	113	64	700	19.5	10	32	2 "	2
oti	83	Normand	"	125	72	570	18.5	11	43	2 "	2
Boats	83 / 90	Schichau	Germany	121 / 128	85 / 88	1000	19 / 22	....	..	2 R. C.	2
vift	85	White	England	150	125	1300	20.8	35	60	6 3-Pd.	2
lke	85	Yarrow	Austria	135	95	1250	22.4	28	50	2 M.	2
Boats	85	Stettin	Greece	128	85	1050	19	20	43	4 R. C.	.....
Boats	85–6	T., W., Y.	England	113 / 128	60 / 75	600 / 1000	18 / 22	10 / 20	37 / 45	2 3-Pd.	1 / 5
lny	86	Normand	France	135	70	700	20	12	38	2 R. C.	2
otaka	86	Yarrow	Japan	170	190	1400	19	50	80	4 M.	6
iborg	86	Thomson	Russia	142	142	1400	20.6	45	72	2 R. C.	3
vel	86	Normand	"	152	96	800	22	30	84	2 R. F.	2
Boat	86	Schichau	China	144	...	1597	24.2	....	..	4 M.	2
o. 80	87	Yarrow	England	135	105	1540	23	30	44	4 3-Pd.	5
Boats	87	Italy	Italy	135	110	1600	24	30	42	1 1-Pd. / 1 R. C.	5
Boats	87	Yarrow	"	140	100	1600	25.1	30	42	2 3-Pd. / 1 R. C.	5
iete	87	Thornycroft	Spain	148	97	1600	26.1	25	35	4 3-Pd.	2
ureur	87	"	France	148	120	1550	23.5	22	32	4 M.	2
Boats	88	"	Denmark	138	95	1200	22.5	15	28	2 1-Pd.	4
arme	88	St. Nazaire	France	151	148	1400	20.5	40	64	2 3-Pd.	4
uila	88	Schichau	Italy	152	130	2200	26.6	40	41	2 3-Pd. / 2 1-Pd. / 1 R. C.	3
ile	89	La Seyne	France	139	103	1100	20.4	14	29	3 3-Pd.	2
Boats	89	Creusot	Japan	115	56	525	20	....	..	2 1-Pd.	2
Boats	89 / 90	Gaarden	Turkey	127	85	1300	22	20	34	2 R. C.	2
rature	90	Thornycroft	Argentine	150	110	1500	24.5	22	33	3 3-Pd.	3
ler	90	Schichau	Russia	152	130	2200	27.4	....	..	.....	2
shing	90	Herreshoff	U. S.	138	106	1720	24	39	51	3 1-Pd.	3 / 18" S.
Boats	91	Schichau	Japan	125	90	1300	23	24	41	.....	3
Boats	91	Thornycroft	Brazil	150	150	1800	25.4	22	27	2 1-Pd.	4 / 14"
agon	92	Normand	France	138	119	1400	25	16	26	3 3-Pd.	2
rsaire	92	St. Denis	"	160	150	2500	25.5	15	13	4 1-Pd.	2 / 18" L.
icsson	92	Dubuque	U. S.	150	120	1800	24	40	50	4 1-Pd.	3 / 18" S.
dro Ivo	92-3	Schichau	Brazil	152	130	2200	26	30	31	2 1-Pd.	3
nsquenet	93	Nantes	France	165	138	2800	24.5	18	14	2 1-Pd.	2
ousquetaire	93	Graville	"	154	125	2100	24.8	18	19	2 1-Pd.	2 / 18" L.
evalier	93	Normand	"	144	118	2700	27.2	17	14	2 1-Pd.	2 / 18" L.

Torpedo-Boats.—*Continued.*

Name.	Date.	Builder.	Nation.	Length.	Tons.	I. H. P.	Speed.	Coal.	Lbs. per I. H. P.	Guns.	Tubes.
10 Boats	93-5	Y., T., W., L.	England	140 / 142	100 / 130	1430 / 2690	21 / 24	18 / 26	28 / 22	3 3-Pd.	3
5 Boats	93-4	Schichau	Germany	144	125	2500	25	....	..	2 R. C.	3
19 Boats	93-5	.....	Italy	131	85	1000	22	7	16	2 1-Pd.	2
4 Boats	94	Schichau	China	...	120	....	24.5	....	..	2 R. F.	2
Aquilon	95	Normand	France	138	120	2000	26.2	17	19	2 3-Pd.	2
8 Boats	95	Schichau	Germany	144	140	1500	22	....	..	2 R. C.	3
Forban	95	Normand	France	144	130	3250	31.2	15	10	2 1-Pd.	2 / 14″
Viper	95	Yarrow	Austria	148	120	2000	26.6	30	34	.....	2
6 Boats	95-6	....	Russia	138	118	...	25	...	..	.....	2
5 Boats	96	.. ..	France	121	80	1500	24	14	21	2 1-Pd.	2
Mangini	96	Nantes	"	147	129	2100	25	17	18	2 3-Pd.	2
1 Boat	96	.....	China	137	120	1250	20	....	..	2 3-Pd.	2
4 Boats	96	.....	Spain	147	97	1600	25	25	35	.....	2
Natter	96	Schichau	Austria	151	150	2268	26.5	30	30	2 3-Pd.	3
Cyclone	Bldg.	Normand	France	...	148	3500	31	....	..	.....	.....
Nos. 3, 4, 5	"	Columbian Iron Works	U. S.	160	142	2000	24.5	50	56	3 1-Pd.	3 / 18″ S.
Nos. 6, 7	"	Herreshoff	"	175	180	4000	27.5	68	38	4 1-Pd.	3 / 18″ S.
No. 8	"	Moran Bros.	"	170	182	3200	26	60	42	4 1-Pd.	3 / 18″ S.
Nos. 9, 10	"	Bath Iron Works	"	147	146	4200	30	32	17	4 6-Pd.	3 / 18″ L.
Nos. 12, 13	"	Wolff & Zwicker	"	146	117	1750	22.5	25	32	3 1-Pd.	3 / 18″ L.
No. 14	"	Herreshoff	"	140	103	1750	22	28	36	3 1-Pd.	3 / 18″ L.
Nos. 15, 16	"	"	"	100	47	850	20	....	..	1 1-Pd.	2 / 18″ S.
No. 17	"	Chas. Hillman	"	102	65	850	20	16	42	1 1-Pd.	2 / 18″ S.
No. 18	"	Columbian Iron Works	"	102	65	850	20	16	42	1 1-Pd.	2 / 18″ S.

Miscellaneous Vessels.

Name.	Date.	Where Built.	Nation.	Length.	Tons.	I. H. P.	Speed.	Guns.	Tubes.
Vesuvius	74	.....	England	90	245	350	9.7	None.	4
Pietro Micca	76	....	Italy	203	550	1400	14	2 M.	2
Drott	77	Stockholm	Sweden	175	630	900	13	4 R. F.	3
Hecla	78	Belfast	England	392	6400	2400	11.7	6 40 to 64 Pds. / 14 Machine. / 5 Torp. Boats.	5
Japon	..	.....	France	315	3400	1500	11.2	2 Small.	..
Tordenskjold	80	Copenhagen	Denmark	222	2400	2600	14	1 30 cm, 2 15 cm, / 2 12 cm, 8 M.	4
Polyphemus	81	Chatham	England	240	2640	5500	18	6 6-Pd., 2 M.	5
Division Boats	87 / 95	Elbing	Germany	185 / 213	250 / 380	1800 / 4000	21 / 26	6 R. F. & R. C.	3
Vulcan	89	Portsmouth	England	350	6620	12000	20	37 R. F. & M. / 6 Torp. Boats.	6
Pelikan	91	Elbing	Austria	279	2440	4700	18.3	2 6-in., 8 R. F., / 36 Torpedoes.	..
Foudre	95	Bordeaux	France	371	6100	11400	19	16 R. F. / 10 Torp. Boats.	4

Despatch-Vessels and Torpedo-Cruisers.

Name.	Date.	Where Built.	Nation.	Length.	Tons.	I. H. P.	Speed.	Guns.	Tubes.
Zieten	76	Blackwall	Germany	197	975	2350	16	10 M.	2
Staffeta	76	Sampierdarena	Italy	253	1388	1900	14	4 12 cm, 11 Small.	1
Blitz	82	Kiel	Germany	246	1382	2800	16.3	1 4¼″, 4 3¾, 4 M.	1
Alacrity	85	Jarrow	England	250	1700	3000	17.8	10 6-Pd., 2 M.	..
Curlew	85	Devonport	"	195	950	1200	14.5	1 6″, 3 5″, 7 M.	3
Leopard	85	Elswick	Austria	224	1530	6000	18.5	2 12 cm, 10 R. F. & M.	4
Scout	85	Clydebank	England	220	1580	3200	16.7	4 5″, 11 R. F. & M.	(11) 7
Condor	85	Rochefort	France	217	1240	3600	17.7	5 10 cm, 7 R. F. & M.	5
Infanta Isabella	85	Cadiz	Spain	210	1152	1500	14	4 4.7″, 4 6-Pd., 1 M.	2
Greif	86	Gaarden	Germany	318	2000	5400	23	3 3.9″, 10 R. C. & M.	..
Milan	86	St. Nazaire	France	303	1546	4132	18.4	5 3.9″, 8 1 Pd.	2
Archer	86	Clydebank	England	225	1770	3500	16.5	6 6″, 11 R. F. & M.	8
Coreetz	86	Stockholm	Russia	206	1213	1500	13.5	2 8″, 16″, 8 R. F. & R. C.	2
Dogali	86	Elswick	Italy	260	2000	7600	19.7	6 6″, 15 R. F.	4
Tiger	87	Triest	Austria	231	1641	6000	19	4 4.7″, 10 R. F.	4
Archimede	87	Venice	Italy	230	784	1700	16	4 4.7″, 4 R. F. & R. C.	2
Wacht	87	Bremen	Germany	279	1240	4000	20	4 3.4″, 2 M.	3
Isla de Cuba	87	Elswick	Spain	185	1040	2627	16	6 4.7″, 8 R. F. & M.	3
Yorktown	88	Philadelphia	U. S.	230	1700	3660	17.2	6 6″, 9 R. F., R.C. & M.	(8)
Cosmao	89	Bordeaux	France	312	1877	6300	20.5	4 5.5″, 7 3-Pd.	5
Barracouta	89	Sheerness	England	220	1580	3000	16.5	6 4.7″, 6 R. F. & M.	2
Barham	89	Portsmouth	"	280	1830	4700	18.6	6 4.7″, 6 R. F. & M.	2
Falke	91	Kiel	Germany	256	1580	2800	15.5	8 3.9″, 4 1-Pd.	1
Wattignies	91	Rochefort	France	233	1310	4200	18.6	5 3.9″, 13 R. F. & R. C.	4
Kondor	92	Hamburg	Germany	246	1640	2700	16.5	8 3.9″, 5 K. C.	2
Coatit	Bldg.	....	Italy	...	1313	....	23	....	..

Torpedo-Gunboats.

Name.	Date.	Where Built.	Nation.	Length.	Tons.	I. H. P.	Speed.	Guns.	Tubes.
Spalato	79	Triest	Austria	180	840	1000	14	4 9 cm, 8 Small.	2
Sebenico	82	Pola	"	187	840	1200	14	Ditto.	1
Lussin	83	Triest	"	200	840	1000	14	2 15 cm, 8 Small.	2
Bombe	85	Havre	France	197	395	2000	18	7 R. F. & R. C.	2
Rattlesnake	86	Birkenhead	England	200	550	2800	19.5	1 4," 6 3-Pd.	4
Folgore	86	Castellamare	Italy	186	377	2000	20	7 R. F. & M.	4
Tripoli	86	"	"	230	845	3600	20	1 12 cm, 7 R. F.	5
Destructor	86	Clydebank	Spain	193	458	3800	20.2	1 9 cm, 6 R. F. & M.	5
Ilyen	86	.....	Russia	230	600	3550	20.1	13 R. F. & R. C.	7
Meteor	87	Elbing	Austria	187	350	3300	23	9 3-Pd.	4
Sharpshooter	88	Devonport	England	230	735	3500	19	2 4.7," 4 3-Pd.	5
Planet	89	Jarrow	Austria	210	500	3500	19.6	10 R. F.	3
Temerario	89	....	Spain	190	570	2600	20	2 12 cm, 5 R. F. & M.	2
Espora	90	Birkenhead	Argentine	210	615	3500	20	7 R. F. & M.	5
Condell	90	"	Chile	230	750	4350	20.3	3 14-Pd. / 4 3-Pd., 2 M.	5
Meteor	90	Gaarden	Germany	262	946	4500	21	4 R. F.	3
Kazarsky	90	Elbing	Russia	190	400	3500	22	9 R. F.	2
Léger	91	Lorient	France	197	450	2230	18.8	1 10 cm, 7 R. F.	3
Filipinas	92	Cadiz	Spain	233	747	4500	20	2 12 cm, 8 R. F. & M.	4
Alarm	92	Sheerness	England	230	810	3500	19.2	2 4.7," 4 3-Pd.	3
D'Iberville	92	St. Nazaire	France	262	925	506	21.6	1 10 cm, 7 Small.	6
Gustavo Sampaio	93	Elswick	Brazil	196	500	2300	18	2 20-Pd., 4 3-Pd.	3
Satellit	93	Elbing	Austria	220	500	4900	22.5	9 3-Pd.	..
Speedy	93	Chiswick	England	230	810	4500	20	2 4.7," 4 3-Pd.	3
Dryad	93	Chatham	"	250	1070	3700	18.5	2 4.7," 4 6-Pd.	5
Patria	93	Birkenhead	Argentine	250	1183	5000	20.7	2 4.7," 4 8 Pd. / 2 3-Pd., 2 M.	5
Cassini	94	Havre	France	262	958	5000	21	13 R. F.	3
Caprera	94	Leghorn	Italy	230	853	4250	19.8	1 12 cm. / 4 6-Pd., 2 1-Pd.	4
Magnet	96	Elbing	Austria	221	473	3700	26	6 3-Pd.	3
Dunois	Bldg.	Cherbourg	France	256	896	6400	23	12 R. F.	..
Molinas	"	....	Chile	295	1200	.....	....	14 R. F., 2 M.	4

TORPEDO-BOAT DESTROYERS.

Name.	Date.	Builder.	Nation.	Length.	Tons.	I. H. P.	Speed.	Coal.	Lbs. per I. H. P.	Guns.	Tubes.
Havock	93	Yarrow	England	180	220	3500	26.8	57	36	1 12-Pd. 3 6-Pd.	3
Hornet	93	"	"	180	220	4600	27.3	57	28	Ditto	3
Daring	93	Thornycroft	"	185	220	4842	28.6	50	23	2 12-Pd. 3 6-Pd.	3
29 Boats	93-5	Various	"	190 200	220 280	3200 4800	27 29	60 70	42 33	1 12-Pd. 5 6-Pd.	3 2
7 Boats	94-5	Laird	"	210	265 300	4400 6000	27 30	..	..	Ditto	2
Sokol	95	Yarrow	Russia	190	240	4490	30.3	60	30	1 12-Pd. 3 6-Pd.	2
Desperate	96	Thornycroft	England	210	272	5600	30.5	..	..	1 12-Pd. 5 6-Pd.	2
4 Boats	96	Laird	Chile	210	300	6000	30	..	..	Ditto	2
Sante Fé	96	Yarrow	Argentine	190	250	4000	26.5	80	45	1 14-Pd. 3 6-Pd. 2 M.	3
Furor	96	Thomson	Spain	220	380	6200	28.2	..	..	2 14-Pd. 2 6-Pd. 2 M.	2
Durandal	Bldg.	Normand	France	180	300	....	26	100	..	1 9-Pd. 6 3-Pd.	.....
No. 11	"	Union Iron Works	U. S.	210	273	5600	30	..	..	4 6-Pd.	3

DISCUSSION.

Lieutenant E. W. EBERLE, U. S. Navy.—I have read with much interest the paper by Lieutenant R. C. Smith, U. S. N., entitled "Torpedo-Boat Policy," and it is a very instructive history of the evolution of the torpedo-boat.

I agree with the policy of the essayist in attaching great importance to the torpedo-boat, especially in harbor defense, but I regret that he did not designate the swift ram as the "running mate" of the torpedo-boat in this noble work of "aggressive defense." Of equal importance is the torpedo-boat destroyer, its duty being principally with the fleet along the enemy's coast, or upon the adjacent sea to insure the battle-ship against surprise by torpedo-boats.

My opinion is that the appropriation for each battle-ship or armored cruiser should contain a provision for two torpedo-boat destroyers. These two "destroyers" should attend the battle-ship during all manœuvres, and in time of hostilities they should serve as her "faithful watch-dogs" at night, being always on the alert for torpedo-boats and rams. The service that these "destroyers" could render a fleet of fighting ships would prove most valuable—some on the scout and others on the lookout. They could form an inner picket line for the fleet, the outer line being formed by the large cruising scouts. How much more

secure and comfortable the fighting ships would feel, when on the blockade or when approaching the enemy's coast, if each one had two effective torpedo-boat destroyers to insure protection from the ever-dreaded little "night-prowling" torpedo-boats. The two "destroyers" should be a "part and parcel" of the battle-ship and under the orders of her commanding officer; and they should look to the battle-ship for all supplies when cruising and also for protection from the enemy's fighting ships. During action they could often find safety under the unengaged side of their powerful protector and be ever ready to dart forth to repel the onslaught of torpedo-boats. To each coast-defense vessel should be attached one "destroyer" in addition to the number of torpedo-boats that should always accompany a fleet of coast defenders. Thus, for example, a fleet of six monitors should have six "destroyers" and probably eight torpedo-boats and two rams; the "destroyers" would act as scouts and as protectors against the "destroyers" or torpedo-boats of the enemy.

Torpedo-boats should never put to sea excepting to go to the assistance of an engaged fleet a few miles off the coast in comparatively smooth weather; they are really "pure and simple" harbor defenders, and in this valuable service they should always have the rams as their companions.

I think that we have seriously overlooked the great importance of the ram and torpedo-boat in harbor defense. For the purpose of illustration, take the harbor of San Francisco and assume that it has no fortifications whatever, no mines and no torpedoes in its approaches; but let the enemy be aware that within that harbor are about ten torpedo-boats and several rams and "destroyers." Would any commander-in-chief dare enter that harbor with his battle-ships and cruisers? Would he not realize that these little "night-hawks" and rams were hiding in every cove and behind every island within that large bay, ever ready to dart forth at his powerful fighting ships in the darkness or fog and then run for cover behind the many inviting islands? I do not believe that any commander-in-chief would dare imperil his fleet by entering such a harbor, or at least not until he should send in his "destroyers" and they prove capable of driving the little defenders into the shoal waters of upper San Francisco Bay for safety—a somewhat difficult feat to accomplish.

What is true of San Francisco Bay is true of many harbors on our eastern coast, and the illustration goes to prove that torpedo-boats and rams are very important in the defense of harbors, and at the same time it shows that the only way to overcome such opposition would be to have a large number of "destroyers" with the fleet.

I consider the ram to be as important in harbor defense as the torpedo-boat, and they should always be associated; and the ram should also be an important factor in the cruising or in the blockading fleets.

The "moral effect" that torpedo-boats and rams would have upon the enemy would alone be sufficient remuneration for their maintenance; they would prove a constant source of worry to commanders of fighting

ships, because it is realized that these little vessels are ever ready to dart through the darkness and sacrifice themselves in attempts on the life of the huge battle-ships, and though unsuccessful in the attack, the sacrifice is praiseworthy.

In my opinion, torpedo-boat destroyers should be well-built swift vessels of at least 300 tons displacement, of large coal capacity, and with an armament of one twelve-pounder and five six-pounders, or one twelve-pounder, three six-pounders and two three-pounders, *and with three torpedo-tubes* on central fore and aft line.

The torpedo-boats should be more cheaply built, as their chief usefulness is in harbor defense and a fair percentage will be destroyed by the enemy. The torpedo-boats should be of 130 to 180 tons displacement and carry four three-pounders and two or three torpedo-tubes on central fore and aft line, according to size of the boat.

I agree with the essayist in doubting the efficacy of search-lights on "destroyers" and on larger torpedo-boats. I think that the lights would do more harm than good if used in the chase or in attempting to pick up other torpedo-boats. Search-lights on large vessels, which furnish a steady platform and which move with comparatively slow speed, do not give the desired results in clear weather over ranges of much length, and in misty weather they prove utterly worthless. Therefore, as torpedo-boats would naturally take advantage of misty and foggy weather for attacks, the "destroyer" would find its search-light a useless encumbrance, even when not considering the other drawbacks of high speed and unsteady platform.

I think that Captain Evans' suggestion, as stated in the essay, for towing a target in torpedo-boat practice, is a very excellent one, provided the target representing the cross-section of the torpedo-boat is lashed across the gunwale of one of the old condemned sailing launches or other boats that are lying in the sheds at navy yards. This would eliminate the possible collapse of the target when towing at high speed and would permit the towing torpedo-boat to use her highest speed.

When carrying out such practice attacks, why would it not be well for the towing torpedo-boat to fire a torpedo or two, when within range, at a target of suitable limits anchored just astern of the vessel to be attacked? Then, if the target in tow is not hit by a shell while passing through the same zone that the towing torpedo-boat was in when she fired her torpedoes, the torpedo-boat has been successful, provided the torpedoes she fired struck within the limits of the target fired at. If the target in tow is struck by a shell, then of course the torpedo-boat's efforts are thrown out, unless she fired an effective torpedo when at a greater range than that at which her tow was struck. This method, I think, would produce some very interesting results, as it would give the opportunity to fire torpedoes and have the section of a torpedo-boat fired upon while under conditions of actual attack. The only element wanting is that you do not surprise the attacked vessel, unless you have targets anchored both ahead and astern of the vessel to be attacked and allow the torpedo-boat to tow across bow or stern from any direction.

If the torpedo-boat gets a shot on the target before she is discovered she wins, whether her tow is struck later or not. This would give all the conditions that appertain to actual warfare.

I do not agree with the essayist in his assumption that battle-ships should be fitted with torpedo-tubes, and I also consider that torpedoes are out of place in armored cruisers and in large cruisers designed to be used as scouts. I regret that I have not the opportunity here of showing that "battle-masts" or "fighting-masts" in a battle-ship are also a menace to the fighting qualities of the ship. I cannot imagine any circumstance under which a battle-ship would dare use her torpedoes, unless it would be to give the "knock-out blow" to an already defeated and disabled enemy before he could lower his colors; and it would seem poor judgment to approach within torpedo range of an enemy that is already whipped, because *he* might possibly have an uninjured torpedo-tube and that would put both vessels upon an equal footing again, thus possibly throwing away the victory that previously had been won.

Cruisers will use their high speed to avoid engagements with battle-ships, and, therefore, battle-ships will in most cases be opposed by battle-ships or armored cruisers. In such engagements the battle-ships would probably never be within torpedo range of each other, and if by chance they should close to 800 yards, would any commander dare open his broadside torpedo ports and attach the war-head in the face of the terrific fire of his opponent's numerous rapid-fire guns?

A better target for rapid-fire guns at 800 yards than an open torpedo port in the armored side of a battle-ship could hardly be desired, and if the "men behind the guns" fail to explode the air-flask or war-head, they would most certainly destroy the tube itself. Consider the Oregon, for example. She has a bow tube, a stern tube, two starboard broadside tubes, and one port broadside tube. Her bow and stern tubes are fixed, and as they are not protected by armor, they may as well be eliminated from the discussion. The broadside training tubes are behind four inches of armor, which offers little protection against the main battery of a battle-ship. Besides, the broadside tubes could not be opened except in smooth water; the bow tube could never be used when under way excepting at very slow speed, a speed at which the Oregon's helm is of so little use that she must be handled with her engines. It is claimed from experiment that war-heads will not explode when struck by rapid-fire shell unless the small detonator itself is struck; but would any commander of a battle-ship be willing to stake the fate of his ship in battle upon this assumption, merely for the sake of obtaining a chance shot at the enemy, provided his tube and air-flask have not already been penetrated? I do not believe that any commander would so menace his own ship, when in action, as to open his torpedo-ports and attach the war-heads as long as he could fight a single gun. If every gun has been silenced and the enemy should be so indiscreet as to approach within short range, a torpedo might possibly prove successful against him; but when a ship has been so seriously battered as to have every gun disabled, it is hardly possible that her torpedo-tubes remain unin-

jured behind only four inches of armor, not to mention what would occur when the torpedo-ports are opened and the tubes exposed to fire. In my humble opinion, torpedoes in battle-ships, in armored cruisers and in scouts are out of place and are a menace to the ship that carries them, and I believe that in the near future our policy will be: *Torpedoes in torpedo-vessels and in nothing else.*

I do not agree with Lieutenant Smith in his statement that vessels of the Yorktown class would make "efficient scouts" if "stripped of their heavy guns, etc." The scout must be large, with high speed, large coal capacity and excellent sea-going qualities, because a scout's duty is to pick up and keep in touch of the enemy in any state of weather, and then run for the fleet. Scouts are not fighting ships; they are the information bureau of the fleet, and their reports enable the commander-in-chief to tell *when* and *where to strike the enemy.*

I may well quote here the splendid words of Commander Goodrich in his discussion on page 555 of the Proceedings. Referring to the scout, he says: "She should be large, for with increased size comes increased steaming radius and the ability to proceed in heavy weather. She should not have torpedoes, for her duty is to observe and report, not to fight. Her safety lies in her speed."

Lieutenant H. O. Rittenhouse, U. S. Navy.—I desire to express my appreciation of the work done by Lieutenant Smith in the study and preparation of his subject, which is at once opportune and important in the highest degree. He has done pioneer work in clearing for us a confused and tangled field, a field, too, upon which, from the present outlook, the action seems certain to depend in large measure. Further than this, he has clearly indicated the lines of policy and construction that it would seem wise to adopt. For my own part I find it difficult to avoid his conclusions upon any point. At any rate, he has so set the facts in order that debate can be kept directed to the issue, and there can be no excuse for delay in settling upon a plan of construction.

Neither should there be delay in commencing construction. The signs of the times are decidedly unfavorable to any further pursuit of that wary policy of inactive watchfulness to which our legislators are so partial. (Let us hope the country may never experience the full measure of its economy!) We need immediately a strong fleet of torpedo-boats to operate from and guard our harbors; and the fleet needs high-sea torpedo-boats for its defense. That systematic and business principles directed to the sole purpose of armaments and the end of battle should be followed in their design and construction, admits of no argument and should need no advocate. It is difficult to conceive of a spirit in such matters that would prefer self-interest to patriotism. These boats, even if not directed against an enemy, would more than compensate for their cost in the experience they would afford officers in the navigation of our pilot waters, in cultivating sea prevision and resource, and in developing trained crews with experience and intelligence available for the most exceptional service.

I am heartily in accord with the essay in the moderate value assigned to the last few increments of extreme high speed when the advantages are weighed against those of other desirable qualities. The value of the last knot is about inversely proportional to the power that gains it, and a sacrifice equivalent to this power is inevitably involved.

Ensign R. H. JACKSON, U. S. Navy.—This essay, a review of the history of the development of the torpedo-boat, showing the tendency of present practice, followed by a logical deduction of the types to be used in the future, with special application to our own service, seems only open to criticism in admission of a third special type of vessel to assist the torpedo-boat as a scout. It is thought that the Desperate type, *i. e.* the destroyers, could perform this duty, assisted at times by such cruisers as might be available for scouting duty.

The selection of an enlarged Cushing or an Ericsson, with broadside tubes only, for the operations from a shore base, and a Desperate for operations with the fleet or at a distance from base, should cover the two distinct fields of torpedo-boat warfare.

A few suggestions, though not within the limits of the essay, are submitted as bearing directly upon the "Torpedo-boat Policy," viz. the minimum number of boats required of each type, the stations assigned, the *personnel* and organization.

1. Number and station: 50 Desperates and 100 Ericssons equally distributed to the following stations: (*a*) Long Island flotilla, covering coast from Boston to New York; the great commercial advantage as well as the strategical importance of a canal across Cape Cod neck would indicate that this undertaking will not be much longer deferred. This would bring Boston into the Long Island Sound district.

(*b*) Bay flotilla, New York to Florida, covering the Chesapeake and Delaware bays and interior communications.

(*c*) Gulf flotilla, from Key West to the Rio Grande.

(*d*) The Pacific flotilla, equally divided between San Francisco Bay and Puget Sound.

The boats to be assigned to the different naval stations within the district, and each boat allowed a section of a store-house in which spare parts and extra supplies are kept. The accounts to be kept at the station, and stores issued on stub orders. At present it requires almost the entire time of one officer to keep the books, make out the requisitions and returns and look after the correspondence.

The successful results attained in use of liquid fuel would point to the early adoption of it, with all the advantages of steam at short notice, smokeless combustion, rapid supply of fuel at stations, and reduction of complement of crew.

In connection with this station system too much emphasis cannot be laid upon the great gain that would result from standardizing as thoroughly as possible these boats, that suitable supplies and spare parts would always be available, and that crews may be immediately familiar with a boat when transferred from one to another.

While a boat might be sent to another station than her own, it should

only be temporarily. The whole history of the boat should belong to one station and locality. When a boat is left with a reduced crew, her stores and equipment would be placed in her own store-room in readiness for active service at a few hours notice.

This reduced crew to consist of a chief gunner's mate and a quartermaster on deck, and a chief machinist and oiler in engine-room. At no time should these men be detached from the boat. Their knowledge and exeprience are invaluable in breaking in new crews and in getting the best results from a boat in a short time.

With these four men on board, a new crew could be drafted to a boat and a successful attack be achieved that night.

These billets would be eagerly sought by men from the station to which the boat is permanently assigned.

An officer in charge of the boats of station, to take each boat out at certain intervals to test her efficiency, drawing men from other boats and receiving-ship for temporary duty.

On active service the officers for a destroyer to be a lieutenant, an ensign and a past assistant engineer.

On the first-class torpedo-boats, a junior lieutenant or ensign only; a midshipman or ensign might be added for specially arduous service or to make up casualties.

Whereas the number of boats required is based upon the probable demands in time of war, yet were these boats only fitted for peace service it would be a most excellent investment, in the instruction that they afford officers in pilotage, navigation and seamanship, with a knowledge of the coast and harbor possessed only by a few officers on the Coast Survey.

Above all, the responsibility of a command which the present generation knows only by tradition.

Lieutenant-Commander J. C. Wilson, U. S. Navy.—The service generally is very much indebted to Lieutenant Smith for placing before it such a clear and comprehensive history of the development of the torpedo-boat and submitting such well-considered suggestions and opinions as to their uses. It is a policy which I believe is less generally understood in the service than almost any other policy appertaining to the use of naval means of attack and defense. The various kinds, sizes, armaments and uses of torpedo-boats have changed so rapidly and multiplied so steadily that the average naval officer has had neither the time nor means of keeping up with the development and the history of failures and successes; so this essay is not only interesting, but exceedingly valuable to enable us to bring our knowledge of the subject up to date. I agree with the essayist as to the doubtful utility of the search-light afloat either for attack or defense in any torpedo-boat work. In general, I believe the importance of the search-light afloat to be overestimated. It should be of great service on blockades, when the vessel carrying it does not expose herself to attack by its use, and it probably would be used to advantage in searching out positions along the coast. Its necessarily exposed position and limited range bring it within range of all

rapid-fire guns, and makes it probable that it would be "knocked out" very shortly in any engagement in which rapid-fire guns played a part.

I think the essayist has shown conclusively what classes of torpedo-boats we should provide for our service, and that unless a systematic, intelligent course is pursued we will find our navy saddled with a lot of unsuitable boats. I agree with him in his deductions that but two classes (not counting the "videttes") can be properly utilized, and in any event we should first determine exactly what we want to do with our boats before building them.

It is time a settled policy of construction was entered upon and vessels constructed accordingly. The country has a right to expect that money and valuable time will not be wasted on construction of "misfit" vessels, and it would seem that the essay by Lieutenant Smith comes at a time when just such light is needed on the subject of torpedo-boat construction.

Lieutenant-Commander RICHARD WAINWRIGHT, U. S. Navy.—The Naval Institute is to be congratulated upon its Prize Essay for 1897. The publication of such an essay cannot fail to strengthen the support of the Institute, while it places before the navy a consistent torpedo-boat policy.

Lieutenant Smith first gives a concise history of the evolution of the torpedo-boat; then points out the special objects for which torpedo-boats should be designed, and, having thus outlined the qualities that have been obtained under various limitations and the qualities desired for the uses designated, proceeds to deduce logically the types that should be selected.

The essayist says: "If a board will first decide exactly to what use the boat is to be put, and what armament, speed, coal endurance and crew she will require for such use, then the displacement and horse-power will follow naturally. . . . If any other method is adopted in producing these boats, then when they are finished it will have to be determined what can be done with them." This may be said of all classes of vessels. Shall we consider to what use the vessels are to be put before designing and building them, or shall we build first and then determine what can be done with them? Shall we have a construction policy, or shall we continue to build our vessels and boats, here enhancing one quality and there another, at the expense always of some other qualities not as popular at the time, or coming under a bureau for the time being less persistent, and then turn this illogical product over to the naval officer to classify and utilize?

The question of a naval policy is a complex one, and it would not be sufficient to have a board to decide upon a type of battle-ship, another upon cruisers, and still another upon torpedo-boats. This no doubt would give us a homogeneous fleet and, therefore, a more effective one than if we adhered to the haphazard plan; but it would not prove the most effective one that could be produced for the expenditure, unless the entire question of the use of a navy to the country is considered, and the qualities required to accomplish these objects and then the types designed to develop the qualities. By this means we would settle many disputed

questions and select from the numerous types the few that are needed. We would find that the principal use of the navy was to defend the coast and commerce of the country. We would define the difference between coast and harbor defense; define the limit between the mobile and immobile forces. We would settle the question between the battle-ship and the monitor. We would cease to advocate fortresses as safe refuges for our weak fleets, and cease to advocate battle-ships of light draught to enter the shoaler ports. We would remove the cloud that now obscures "the fleet in being" and would find that "a passive fleet in being" has few terrors for an active opponent; that the harbors are no place for battle-ships, and that battle-ships alone are suited to fight battle-ships in line. We would find that but a few of the harbors of our coast need defense against battle-ships; that but few need a powerful defense; that the most important points to defend are the advance naval bases; that we need a type of battle-ship to fight the battle-ships, a type of cruiser to collect information and to fight the enemy's scouts, and types of high-sea and base torpedo-boats. We might even settle the vexed question of the *raison d'être* of the armored cruiser and find that a vessel without the fighting endurance obtained from some side armor was useless for scouting purposes, and that auxiliary cruisers make the best commerce destroyers, thus erasing the unarmored cruiser type from our list.

Lieutenant Smith, in considering the general qualities, advocates strengthening the bow, even at the expense of speed, of the smaller type; and one of his conclusions that might be open to question is whether or not it might not be wise to add some protection to the high-sea type. Many torpedo-boats carry three-pounders, and while they are on a very unsteady platform, it would seem as if two or three torpedo-boats might be able to stop one destroyer if the engines and boilers were only protected by coal. This armor might be obtained by a slight sacrifice of speed or a slight increase in tonnage; the latter would entail a slight loss of speed. Whatever conclusions may be reached on minor points, the main points of the essay fixing upon two types for torpedo-boats are based on sound reasoning.

Assistant Naval Constructor R. B. Dashiell, U. S. Navy.—Lieut. Smith's essay is most interesting, and at the present time a more important subject could not have been selected. He has clearly demonstrated the principle, what might be called the fundamental axiom of torpedo warfare, that the unprotected torpedo is a surprise weapon. With this always in view, the following conclusions seem self-evident:

(1) The torpedo-boat must be as small as possible, to obtain a degree of invisibility and immunity from discovery.

(2) She must be not only speedy, to run in quickly to torpedo range after discovery, but must have machinery capable of attaining her maximum speed instantly upon discovery.

(3) She should carry the best torpedo outfit possible, for this is her weapon, and only such guns as would enable her to overcome a vidette boat.

(4) As the chances are against her ultimate escape after attack, she should be as cheaply constructed as thorough efficiency will permit.

All these qualifications point to a small size boat. The Ericsson type seems to fulfil all requirements for such a boat, as the essayist clearly shows. But a change in her armament of guns is suggested. With nearly all our other boats, she mounts the 1-pdr., a gun which has been recently shown to be utterly powerless to stop a torpedo-boat (much less a destroyer) by injuring her vitals. This gun is therefore so much dead weight to carry about. Though possessing greater penetrative and mining power than the 1-pdr., the 3-pdr. (with ammunition) is just four times as heavy, requires more men to serve it, greater deck room, and will score fewer hits, while its recoil is so vicious in its strains upon fastenings (which must be made extra heavy to meet such strains) that all things considered, the actual value of the gun compared to the price paid for its emplacement becomes exceedingly small.

It would seem, therefore, that the machine gun is the best arm with which to check interference from vidette boats that cannot be rammed and overrun. It is light, can be mounted anywhere in a convenient socket, requires but two men, and the hits scored will be fifty to one of the single-shot gun.

Such a boat can be built for under $100,000.

Turning now to the larger type of boat, a vessel of 250 to 300 tons, the first question that presents itself is, what are the advantages possessed over the 120-ton boat? The essayist seems to select the type for the increased sea-going qualities and the ability to mount a heavy gun battery. But if the nature of our coast and the character of the defense are considered, our ports appear as the natural shelters from which the boats would make their attack. The weather must always be selected, and, as the essayist states, if the sea is too heavy for the boat to manœuvre it is unfit for torpedo work. Therefore the small boat would evidently do the work as well as the larger, her sea-going qualities being fully equal to the duty required of her.

The next consideration is the ability to carry a gun armament, presumably to destroy the enemy's boats. Her value as a destroyer depends upon the probability of torpedo-boats ever forming an important part of the hostile fleet in an attack on this country. To reach the coast there is broad water to cross, and it is not reasonable to anticipate attacks with torpedoes from any but able sea-going boats of the destroyer type, capable of accompanying the fleet at sea in all weathers. It is not wisdom to meet destroyer with destroyer; the gunboat and cruiser must be depended on to crush that type with heavy gun fire from a platform the comparative steadiness of which guarantees good gun practice. If then there be few or no torpedo-boats in the enemy's fleet, why build destroyers for the defense? Other countries are building them, but their policies, their geographical positions, are very different from ours, and their types of weapons will consequently be different. With France at convenient distance for torpedo-boat raids, England naturally builds her 98 destroyers to match the 241 French torpedo-boats. The destroyer type thus becomes a most successful and popular one, and the smaller countries of Europe and South America copy them in their orders for boats, which orders are generally placed in England. But these are not

reasons why the United States should follow the same policy. What this country needs is a *large number* of torpedo-carrying craft; the value of the arm is directly proportional to the number of craft; if *five* sea-going 120-ton boats can be built for the same price as *two* 300-ton boats or destroyers, and appropriations are limited, can there be any question as to the type to be selected, both types being equally efficient for torpedo work?

The third type of vessel upon which torpedoes may be reasonably installed is the heavier cruiser or battle-ship, where the tubes are below water or protected by armor. In such vessels the torpedo is not a surprise weapon, but is used with the full knowledge of the enemy and with the ship fully exposed to counter attack against which no skill or protection can guard. Is such jeopardizing of one's ship permissible? It seems most foolhardy, most unreasonable. The art of war is to overmatch and crush an enemy by massing superior force on a weak point, *not* to match equal with equal and trust to luck for the result.

The over-water tube even behind armor is not protected, and before torpedo range is reached and after the gun contest, the fittings of port, tube, etc., will not be likely to be found in working order. Add to this the great additional weight of the torpedo installation, the cutting of large holes in the ship's side armor—armor placed there to protect her buoyancy—and the relief to the mind of the commanding officer not to have the additional complication of torpedoes to bother him, and there seems but little reason left for retaining this weapon on a vessel whose main offensive power lies in her guns. Indeed, for no other reason than the last given, the removal of torpedoes from all vessels but torpedo-boats might be advocated. The strain thrown upon hull and machinery under forced draught to obtain high results is as nothing to that imposed upon the brain of a captain going into action with all the complicated machinery in the conning tower to run, his tactics to think out, the enemy to watch. The conning tower is so crowded with steering gear, engine annunciators, torpedo directors, range finders, range indicators and similar interesting toys that the men to run them have no standing room at all.

Is there a commanding officer in the service who would not be glad to see a few of such "clock-works" removed? If there is such, he would change his mind after a few experiences of steering a course, getting under weigh, or handling the ship from the conning tower alone. So let us clear out at least the torpedo-directors, torpedo speaking-tubes, telegraph and firing keys, and give the *brains* of the ship a chance to think.

The wooden vidette launch to be carried by the bigger ships is most heartily endorsed; it is just the type of boat most needed in the service. But if a higher duty than 12 knots be required of her, she will be much lumbered up with machinery and boilers.

In naming our boats, are not the names of our venerated admirals far more suitable to a vessel of the worth and dignity of a great battle-ship, and their personal qualifications more in keeping with those of such magnificent machines, than for such dashing craft as our gallant little

boats? The chief *personal* (for the boat to a sailor is a living thing) characteristics of the torpedo-boat are youth, dash, ready sacrifice. If personal names are to be employed, are there not enough Cushings, Flussers, Talbots—enough of the all-but-forgotten names of midshipmen, ensigns, lieutenants, who have given their lives for their country, to give to each boat a *young* hero's name—*pour encourager les autres?*

Wm. Laird Clowes.—It is a matter of regret to me that pressure of work prevents me from devoting to Lieutenant R. C. Smith's interesting paper the time and attention which his subject, and his manner of treating it, deserve. With the recapitulation of his conclusions as to the Torpedo-boat Policy to be pursued by such a power as the United States, I most cordially concur. At the same time I venture to think that perhaps he has not sufficiently underlined the importance of the work to be done in the naval warfare of the future by a modified Polyphemus or Katahdin; and I also venture to think that, incidentally, he gives somewhat too much importance to the ram. Of course, if only you *can* ram you are likely to inflict fatal damage upon your opponent. On the other hand, experience tends to prove, firstly, that you cannot, as a rule, ram effectively until your opponent has been rendered practically harmless and has ceased to be under control, unless indeed she be without room in which to manœuvre; and, secondly, that when you do ram effectively, you are extremely apt to do almost as much damage to yourself as to your foe.

Those are points to be carefully considered ere you set to work to build rams, with or without torpedo ejectors on board of them.

Upon the general question of the best type of torpedo-boat for war service, it is pertinent to bear in mind that although a torpedo-boat, or even a destroyer, is, relatively speaking, an inexpensive craft, and that though her expenditure in action would mean at worst no very appalling loss of life, she is, as at present built, a risky and dangerous weapon. She has her torpedoes on deck exposed to the possible rain of missiles from machine and rapid-fire guns, and should a stray shot strike an air-chamber or a torpedo's nose, the most fatal results are likely to follow.

Would it not, therefore, be worth while to add, or, rather, to prefix, to Lieutenant Smith's list of most desirable torpedo craft something like the following: Let us imagine a very handy vessel with a well-armored turtle-back like that of the Polyphemus, yet thicker, with twin screws; with only light guns; with no ram; and with a couple of submerged tubes on each broadside. A speed of 18 or 19 knots, sufficient to enable her to keep up with a fleet, would be enough. She would be almost impervious to gun fire, and she would be deadly to anything within 500 yards of her. She would use her guns only to keep off and disable other torpedo craft, and even if all her guns were put out of action, she would be offensively as formidable as ever.

I believe that this is one of the torpedo vessels, if not *the* torpedo vessel, of the future. The other types recapitulated by Lieutenant Smith appear to have their places and duties for the present, but when the new type of which I speak appears it would be practically supreme. The new

type, I admit, will not be comfortable to live in unless means be adopted for submerging her only just when she is needed for action, and for enabling her, when cruising, to float high; but those means could be easily devised. Another point apparently worthy of consideration seems to me to be that the adoption of such a vessel as I describe would obviate, at least for a time, the need for making further costly and dangerous experiments with submarine boats. I am no believer that the latter will develop into efficient weapons for many years to come. In their imperfect state I grant they will possess a normal power of great value; but so also will the armored and approximately shot-proof boats which I advocate. And the latter are both cheaper to build and safer for their crews; while, moreover, there can be no question as to the possibility of making them do all that they are wanted for.

Naval Constructor Wm. J. Baxter, U. S. Navy.—The author deserves congratulation upon the able manner in which he has presented to the Institute the results of his researches and experiences. The mass of facts showing the development of the torpedo-boat has been presented in a style and with a completeness beyond question, and those who have never attempted similar researches cannot conceive the labor involved in producing results which so concisely and clearly represent the progress of naval construction in this direction.

It is to be regretted, however, that he was unable to carry his investigations further and record the results of service use upon foreign torpedo-boats of the various types. From papers, periodicals and our own Naval Intelligence reports, we know that many defects of design and detail have occurred. The defects of design are eliminating themselves as development expands along specific lines, but the defects of detail are rarely mentioned. Has not experience shown that simplicity is even more desirable and necessary in the torpedo-boat than in the battle-ship? Leaving all other considerations aside, may it not be considered an absolute necessity that on small boats where it is necessary to change the crews every three or four days, every part and fitting of armament, machinery and hull should be of such simple construction that the average seaman may learn how to efficiently operate them after a few hours instruction?

I greatly sympathize with the author's plea for some standardization of torpedo-boats, for it is precisely in the line of improvement which I have at other times endeavored to show is one of the most urgent and important questions to be solved in the near future, and some considerable experience with ships of the "new navy" has accentuated my former beliefs. The author's proposed method of having a board "decide exactly as to what use the boat is to be put" cannot be considered as his deliberate opinion, for he and all the rest of us know very well that no board can decide upon this question, as the exigencies of the service to-morrow will be entirely different from what they are to-day. A suitable board of experience and ability can decide as to the probable uses of any type of vessel during the next one or two years, but experience should also cause them to consider the probable changes which will occur during the

next three or four years. Fads may be very well as a pastime, and they have done much in the development of the new navy, but the probabilities are that the fad which is the most popular the day the ship is designed, and which is the most artistically developed on a draughtsman's *chef d'œuvre*, that this fad will be most criticised, and will be the least serviceable when the ship is completed and subjected to service conditions.

Wise conservatism and intelligent simplicity are, and should be, the ruling principles with us, and I heartily concur with the author's efforts to secure them, although we may differ as to the methods.

Lieutenant PHILIP ANDREWS, U. S. Navy.—Lieutenant Smith's essay on torpedo-boats comes at a most opportune time, and is a very exhaustive technical compilation of the features of torpedo-boats and destroyers.

In view of Mr. Smith's extensive experience with the Cushing and with torpedoes, I am sorry that he did not give the Institute more of his opinions and conclusions, in addition to the large amount of data which he presents in this convenient form. I should like to hear more about the handling and tactics of the completed torpedo-boat, in groups or singly; features which interest the sea-going officer more than the development of the boats.

There is one feature to which attention should again be called: the advantage which would accrue by cutting a few more canals along our Atlantic coast. A canal across Cape Cod peninsula, for instance, would be but nine miles in length, would cost little, and would give tremendous advantage in the use of a small torpedo flotilla. It would also, if made big enough, cut off the rough and foggy trip around Cape Cod in going to Boston. There are several other points where canals should be cut, but the Cape Cod canal is instanced as probably the most important example.

This subject should be agitated through the commercial interests affected till legislation is secured. There is no more important feature of the conduct of a torpedo flotilla on our eastern coast than the most complete inland water communication.

(*Discussion continued on page 153.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

INTERNATIONAL ARBITRATION: HOW, AND HOW FAR, IS IT PRACTICABLE?*

By Hon. John A. Kasson, LL. D.,

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Introduction.

It is not so very long ago that the naval commander strode the quarter-deck of his ship and looked at his hundred guns with something of the air, and of the manner, of a champion of the ring. He utilized his guns very much as the champion employed his fist. If he wanted an island in the Spanish Main, he knocked down its defenses and took possession. If he wanted some treasure from South American mines, he captured the galleon which transported it. If a merchant of his country wanted a port, or a trading post, which was occupied by a national rival, he sailed in, shot down the stockade, and seized the place. If a foreign tribe or people had no wish to buy the rum, or the opium, exported by his countrymen, he delivered a few broadsides of cogent argument to teach them their duty in swallowing the offensive doses of his national merchandise. If a neutral and weaker fleet lay in its harbor where his enemy might possibly utilize it, he ranged alongside and took possession of it, to teach them the folly of being neutral when a fight was going on. If a naval or commercial rival was forging ahead too conspicuously, he was only too eager to make the ocean dangerous for a rival's navigation. The presence of his flag was a challenge to fight. His national interest was his international law. His joy was in a windward position, the roar of his guns, and the crashing of naval

* Delivered before the U. S. Naval War College, September 19, 1896.

timbers. His courage was reckless, and his cockpit was a butcher-shop.

The nineteenth century, now closing, has gradually introduced a change of scene. The motive power of the ship, and of the officer, has very radically changed. Fickle winds, and a fickle national morality, have given place to a steady propelling power for the war-ship, and a compelling moral principle for the naval commander. There is now an admitted dominion of law over the high seas. It is acknowledged in ports, and protects trading posts and traders even along the Congo, and into the far interior of Africa. The man who treads the quarter-deck is trained in knowledge of this law, and in a scientific school; and is a master of the rules of national morality, as well as of the forces of nature. He seeks to protect human life more than to destroy it. His blows are aimed at the inanimate vehicle rather than at the men whom it carries. The cockpit is a protected hospital instead of a depot of carnage; and anæsthesia converts the knife of the surgeon into a painless instrument of mercy. Neutrals keeping within the law are no longer outraged, and the sea has fewer criminals than the city. International justice is a part of the education required for the quarter-deck. Even diplomacy has left its narrow and secluded lanes, and travels with our fleets. Naval commanders in distant seas have negotiated and won for us new harbors for our ships, new stations for their supplies, new ports for our trade; and new nations, like Japan and Corea, for our commerce and our friendship. In a word, the undercurrent has been toward conditions of peace.

Throughout most of this immense advance to a better condition of the world, the Government of the United States, by their judicial courts, their diplomacy, and their navy, have led the way.

There is, however, a further advance in international civilization for which our Republic has attempted to blaze the path through a forest of difficulties. It is to establish a method by which differences between nations which the usual diplomatic agencies fail to adjust may be honorably settled without a resort to war.

At first blush it seems incongruous to address the members of the war-making department of government upon the means by which their active employment may seem to be rendered unnecessary; but I cannot forget that their arms have often been used

in aid of a higher civilization, and to secure honorable peace, and that their intervention in our times is much more often a guaranty of peace than it is a menace of coming war. The naval or military officer of our day (I think it may be safely affirmed) now regards himself as an armed guardian of international peace, not as a challenger to combat, impatiently awaiting the order to fight. The noble-minded Frederick of Germany responded to my allusion to his brilliant experience in three wars, that he "hoped he should never see another battle." In this I believe he spoke for all conscientious military officers of the Christian civilization. The intelligence and influence of such officers may also have great effect in helping their governments to a wise conclusion in respect to the limits within which a system of international arbitration may be safely adopted. For no man acquainted with modern history, and with the present condition of international relations, can (in this generation at least) indulge the dream of a practical scheme of arbitration which shall include *all* nations, or *all* the subjects between nations.

I shall, therefore, with the encouragement of the accomplished President of this War College, speak briefly to you upon this pregnant and much mooted question of international arbitration, and how far it is practicable.

"International Arbitration: How, and How Far, it is Practicable."

The Duke de Sully, who was the great minister of a great sovereign, and a philosophic thinker and statesman, and fully acquainted with Henry IV's plan for European peace, gives to posterity a needed warning against ill-considered enthusiasms. He says in his "Memoirs," "The mind of man pursues with so much complacency, nay even with so much ardor, whatever it fancies great or beautiful, that it is sorry to be made sensible that these objects have frequently nothing real or solid in them."

It is impossible to give a better definition of the danger to which the promoters of international arbitration are exposed. The idea of extending the judicial system, by which all the differences between man and man are peacefully adjusted, to all differences between the nations of the earth, and so abolish all the savagery and waste of war, is so captivating by its greatness and beauty that we are indeed sorry to be made sensible of the obsta-

cles in the way of its realization. But such obstacles of the most serious nature do exist; and the means for their removal, or for overcoming them, require deliberation more than enthusiasm. The idea is inspiring, like Constantine's beaming cross in the sky; the means of realization must often be a Constantine's imperial authority, and the discipline and force of his organized armies. That is to say, the Christian governments of our day, however earnest for the preservation of peace, must still be strong to enforce and to resist, or some warlike and ambitious power will strangle our peaceful offspring before its maturity.

It is most fortunate that the close of our century finds the United States, England, and France, three of the most powerful nations of the world, most prominent in civilization, and most competent in war, leading in the consideration of the means for the more constant preservation of peace by some system of arbitration or mediation. If the movement were entrusted to unpractical theorists, clamorous against armies and navies, or if it were urged only by weak and unwarlike nations, it would be wholly ineffective. The effort would simply invite the attention of the strong and grasping to their neighbor's weakness. It would be the hornless lamb walking into the herd of lions to remonstrate against their going about with such sharp teeth and cruel claws. The world has not yet reached a point of Christian civilization where a national lamb, without horns, can assure itself of peace anywhere among the lion herd, except inside the lion. Witness Holstein and Hanover, witness Egypt, witness Madagascar, witness South Africa, and Central and Southern Asia, events that have occurred before our own eyes. Americans must still believe the declaration of the father of our country, that in order to assure peace we must be prepared for war. A nation resolute for peace must be ready to enforce it. It must merit the eulogium which Mark Twain's hero bestowed on the mayor of a rough mining town in the Sierra Nevada: "He was a great man for peace, he *would have* peace even if he had to fight for it!" Europe owes the continuation of its peace during the last twenty-five years to that strongly armed mid-European league which was devised by the great statesman whose policy was named as "iron and blood." A mournful burden, I admit, is this costly preparation for war, but not so mournful as the dreadful visitation of war itself.

In the present conditions of international morality, we must approve the defensive armaments and armies of peace-loving nations, and justify their gallant sailors and their ships of war for the maintenance of the peaceful and the just against the war-like and the unjust. Both, in the state of affairs now existing, exercise the useful functions of a strong international police. They can only be abolished when international crime ceases; just as our civic police with their clubs and pistols can be disbanded only when criminals become righteous and peaceful.

There are some professional advocates of peace at all hazards, and at any price, who unhesitatingly ignore history as well as present national conditions. They broadly condemn all wars as acts contrary to the traditions of our religion. They forget that their own liberty to profess and practice their faith was secured to them by long continuous wars on land, and many bloody victories at sea. They should remember that neither the God whom we worship nor the Christ who gave the later Divine Word to the world condemned the army or the soldier. The former, according to the Prophets, raised up armies, and commanded them to war. The latter, instead of rebuking the military service of the Roman centurion, commended him for his faith, and gave him his blessing; and he only commanded the private soldiers to be contented with their wages, and to avoid violence to individuals and false accusations. Instead of assailing military institutions, needful in those times as they are in ours, he warned military men against their misuse, and so marked out the proper course of action for us.

Whether this be the true religious view of the military question or not, the paramount and controlling fact remains that it *is* the view of all the Christian governments with which we have to deal. If we proceed upon the opposite view we shall speak to deaf ears. It is folly to ignore the lessons of history. Hitherto God has wrought out the conditions of advancement in Christian civilization chiefly by the aid of armies and navies. Remember the Roman Republic and Empire which opened military roads and the world for the spread of Christianity; the military dominions of Constantine and Charlemagne by which it was protected; the military establishment of the Reformation, and of the rights of conscience and personal worship, by the heroic fighting of North Germany, and of Holland and England by land and sea.

Attest also the American Revolution in behalf of liberty; and our great war in the overthrow of slavery; and even the terrifying overthrow of European despotism in Church and State by the exploding forces of the French Revolution.

In the evolution and advancement of the soul and mind of man and of his civilization we have the correlative illustration of the successive creations and progress of the physical world. As the Almighty in the latter exceptionally employed the volcano, the earthquake, the tornado and the thunderbolt, acting outside the scope of ordinary and peaceful forces, so does He in crises of human progress make use of the violent forces in man to forbid the destruction of human right, and to establish justice. When this round continent is completed, earthquake and volcano will cease. When man's development is perfected, armies and navies need exist no more.

Our function therefore does not seem to be to encourage a crusade against armies and navies, against soldiers and sailors. It is rather to diminish so far as possible the occasions for employing them in actual war. This is a practical and practicable duty in which we are assured of our accord with the Divine will, and in which we shall have the sympathy of most governments, and the respect of all.

In what way can this good and Christian work be most wisely conducted? What is it best to do, and best to avoid doing?

It is decidedly unwise to attempt in the beginning to include too many nations in the same convention. Some of them have uncompleted national purposes, partly just, partly unjust, but which can only be accomplished by the free military arm. Russia, whether right or wrong, *will* have an open port within Corean or Chinese territory, and an open course to the Mediterranean Sea. Austria and Italy and Greece *will* assert their claims to a part of the European territory of Turkey upon the break-up of that empire. France will not relinquish her right to war for the recovery of her lost departments nor for her colonial expansion in Africa. Germany will not arbitrate her right to existing provinces won in her late wars. England will not arbitrate her right to colonial conquests, nor (for the present) the duration of her occupation of Egypt. The United States will not submit to any tribunal their policy initiated by President Monroe. Strong nations are as fond of their freedom of action in emergencies as

is the individual man in his personal relations. There are some nations and more questions which cannot for many years to come be brought within the scope of international arbitration. We must abandon as only a lovely dream of a far future possibility all idea of a universal system of arbitration, whether universal in respect to nations, or universal in respect to the questions to be submitted to arbitration.

The difficulties—I may almost say the impossibility—of embracing many nations in the same scheme were made apparent in the Pan-American Conference of 1890, the story of which is well worthy of remembrance in this connection. There were eighteen Governments represented in the Conference at Washington by accredited delegates. Every one of the seventeen continental and independent American Governments was represented, with addition of the insular Government of Hayti. Only one of the nations was Anglo-Saxon in origin, one was Franco-African, one Portuguese, and fifteen Spanish. Consequently it was necessary to reconcile many different hereditary opinions, political tendencies, and various intellectual training. One of the principal questions submitted to the Conference was that of a general system of international arbitration embracing the eighteen governments. The *projêt* of such a convention was indeed nominally adopted by the representatives of fifteen States; but the two most powerful and intelligent States refused their assent to it. They would have approved of the rule of arbitration in the majority of cases, but demanded that questions of independence and of national dignity and honor should be excluded from the compulsion of the act. With that condition they were willing to make mediation before war compulsory for all other cases. The opposing delegates were headstrong, and the *projêt* draft was adopted by a majority only, without the sanction of Mexico or Chili.

The second article of this Pan-American Convention made arbitration obligatory for a specific list of differences. The third article made it equally compulsory for all other disputes, saving only, by the fourth article, a controversy which a government may regard as imperiling its independence. Thus it was sought to bind the independent action of each sovereignty throughout all the unknown and unknowable conditions of the future, saving only this one right reserved by each to judge whether its independence was endangered. From a practical statesman's point

of view, it is not surprising that only the weaker governments afterward ratified an agreement so reckless of future contingencies. The majority declined all further action upon it. The United States Government itself never approved it, nor submitted it to the Senate for ratification. In compliance with a vote of the Conference our State Department transmitted the *projêt* to European Governments, by whom it was at once committed to their dusty files—*in memoriam*—in some cases without even acknowledgment of its receipt.

I have recited these facts as indicating that all attempts to establish an universal system of arbitration by a single contract including many nations, will be fruitless, and a vain expenditure of labor. Experienced statesmen will have nothing to do with sweeping generalities, binding their nations for an unlimited time and unknown future. Nations cannot be brought to such an absolute agreement by large groups. Their interests, hopes, and ambitions are too diverse to be covered by identical provisions. Two nations only, masters of the knowledge of their past, present, and probable future relations and disagreements, can be expected to provide permanently for submission of their differences to arbitration. Even in that case there is doubt if they will ever agree to submit all differences without reserve. There must be a specific list of those which shall be submitted, not a specific list of those excepted. That was a fundamental mistake in the *projêt* of the American Conference. Had they limited compulsory submission to certain agreed points, treaties between each of them and the United States might now be in existence.

Nor is it probable that for many years to come governments will see with sufficient clearness the character of the differences likely to arise between them to accept the ideal of a permanent court of arbitration. Among the objections to be offered to that theory is the need in many cases of technical knowledge which requires a special selection of arbitrators with reference to the points in dispute; the differing views of law and justice in which the lawyers are trained in the various countries from which the members of such a court must be chosen; and the dependence of such judges in several countries upon political direction. Such a tribunal might be more wisely appointed, at the beginning, for the purpose of preparing a code which should give definiteness

and precision to the rules which should govern a court of arbitration. After the ratification of such a code the trial court might be safely established.

Former Schemes for Maintaining Peace.

Often in the course of the world's weary history have men turned their attention from devastating war to the Christian prophecy of "Peace on earth, good will to men." Authors and statesmen, both the powerful and the powerless, have conceived various devices for the introduction of this hopeful era. But no such device has been self-executing; physical force was always arrayed behind it. The often quoted precedent of the Amphictyonic Confederation of Ancient Greece appears to have suggested most of these plans. But that institution was as much administrative as judicial. The limits of its power are not definitely known. It interposed between the twelve small kindred states composing it, and seems to have engaged at times in composing the troubles of individual cities. It certainly mediated between them, gave decisions, and enforced them by fines, by expulsion from the confederacy, and even by war. It is not therefore a model for the proposed system of arbitration between states of our civilization. We propose no scheme which requires the use of force, or any other form of physical punishment. Our only compulsion will be that of morality and honor, and the national shame which follows their violation. These are positive and recognized forces in Christendom as they never were among the Greeks.

Nor can the scheme of Henry IV of France, of which the honor of conception is divided between him and Elizabeth of England, furnish a model of any utility for our times and purposes. The most important part of their scheme was aimed at the dismemberment and humiliation of the powerful house of Austria, the spoils of which were to be distributed among princes and republics to purchase their adhesion to this project. When, by such bribery, followed by the contemplated war, they should have united the rest of Europe, and compelled the assent of Austria and Spain to the proposed reorganization of nations and new disposition of territory, then, and only then, was what he was pleased to call the great Christian Republic of Nations to be called into existence. The apportioned delegates of the associ-

ated governments were to meet in common council for the regulation of any dissensions which might thereafter arise between them. Even then it was not to be a simple council of arbitration in the interests of peace. It was to be an assembly with power to apportion assessments and warlike charges among its constituents for the purpose of prosecuting war against the Mohammedan power of Asia. The death of England's great Queen, followed by the selfish indifference of King James, was a severe blow to the scheme, such as it was. Henry, however, still prosecuted it, and was secretly gaining some adherents in Germany and the north, when the dagger of Ravaillac terminated the career of this most noble and picturesque monarch of Europe. With him disappeared from the historic scene that great plan for abolishing the occasion of all future wars between Christian nations by one great contest of mingled diplomacy and force for the redistribution of power in Europe. The project was appropriate to those warlike times, and it ennobled the fame of France by Henry's repudiation of all intention to profit himself by the dismemberment of Austria and Spain. But no part of the scheme offers an example for our times and international circumstances.

The Peace of Utrecht (1713) established new territorial relations and limits. In the period following these treaties the Abbé de St. Pierre, who had been present at the conferences, and knew the deplorable effects of the long wars in which Louis XIV had been engaged, published (1729) in three volumes a scheme for securing perpetual peace on the continent, with a voluminous argument in support of it. His plan seems to have been inspired by that of Henry IV, and assumed that the new international boundaries would be perpetual. According to him, each of the powers was to renounce the right of war against the others. An assembly of the delegates of all the powers was to determine the mutual disputes by a majority of three-fourths of the delegates. Nineteen principal governments were to have one vote each, minor states and free cities together to have one vote in this general diet. A refractory member was to be compelled to obedience by the combined arms of the others. The spirit of the good Abbé was commended by the good people; but the general verdict was that it was merely the " dream of a good man." A distinguished Cardinal said that the Abbé should have first provided for the conversion of men into angels.

Prerequisites of Universal Peace.

At that time neither rulers nor philanthropic prophets foresaw what God's providence was providing for mankind, even within a century, by the aid of wars more extensive and more disruptive than that generation had ever known. After some renewed hostilities on the continent and on the seas, the way was opened for our American independence; and this was followed by the revolutionary and dethroning wars of France against all Europe. The sequel showed how vain and transient would have been the peace system of Henry or the scheme of St. Pierre, both of which were founded upon the mere agreement of transient crowned heads, and upon the theory that transitory boundaries could be made eternal. There were moral forces, suppressed but fermenting, which must first find expression in the liberty of individual and national development before permanent conditions of peace could be established. The explosion in France prepared the necessary emancipation, and from that time on Providence has been more visibly working, even through wars, for the establishment of universal peace. Witness the necessary enlargement of the United States to the Pacific Ocean, the permanent union of Italian states, the consolidation of German states, the incorporation into Russia of Asiatic states, and the union of Central Europe from the Baltic to the Mediterranean in a defensive bond for the preservation of peace. The retrospect of the philosopher discovers in all these the divinely ordered preliminaries of national contentment, which is a requisite condition of permanent peace. If the declarations and labors of Americans are to have any influence upon the action of international statesmen, it is of prime importance that we show an appreciation of present national conditions, and recognize also the possibility of future international readjustments, unforeseen, but dictated by that higher power which we call Providence. We must neither ignore history nor the actual controlling motives of chiefs of states, and the desires of nationalities. Some nations are already territorially rounded out and completed; others are not. In some the aspiration for unity of race and language is satisfied; in others not. In some, national independence is firmly established; in others it is insecure or oppressed. No universal agreement, therefore, for the renunciation of the right of conquest, or

for unrestricted arbitration of disputes, can be expected at the present time. As each generation removes some of the obstacles, and more and more satisfies legitimate national and racial aspirations, there remains always the brighter hope of the future.

The United States, England, and France.

Several groups, however, of two or more nations, stand already in such relations to each other that their respective ministers could to-day wisely and safely entertain propositions for a permanent rule of arbitration, which should be binding on both in respect to the majority of their probable differences. Our attention will be most usefully directed to these groups, and more especially to those of which our own country is a constituent. For example, consider the two groups of nations composed of

First. The United States of America and the kindred nation of Great Britain;

Second, of the United States of America and their lifelong friend, France.

What are the conditions which render the proposed system of arbitration between the two States first named peculiarly practicable?

1. A like education of their people and of their statesmen in identical principles of law, of religion, and of justice, which predisposes them to a common judicial view of right and wrong. 2. A common language, literature and press continually interchanged, together with an unceasing personal, social, and commercial intercourse, which leave little opportunity for angry misconceptions to crystallize into hostile resolutions. 3. Both nations entertain common views of the duty which a Christian civilization owes to liberty and humanity. 4. For one hundred years they have been accustomed to settle all their extreme disputes, save one, by arbitration or reference, whenever unsettled by diplomacy. 5. Both nations have established an equal reputation for valor and persistence in war by land and sea, and each could inflict upon the material interests of the other enormous injury if the relations of peace were unhappily broken. 6. The many recent expressions of parliamentary and public opinion in both countries which have been formally and publicly exchanged, show that the time is consummately ripe for a general and permanent treaty between the States of this group for the arbitration

of most of the international disputes likely to remain after diplomatic negotiations.

Eighty years have now passed, not without troublesome disputes, to be sure, but happily without war between them; and so we may reasonably believe that the hostilities and passions of that period do not exist in the breast of men of the present generation. Should, however, some question again arise bringing the two nations into angry conflict, we might wait many years before again entering upon such an era of international amiability as that which prevails to-day. It is an obligation of the highest wisdom to do a right thing at the right time.

There is, however, one very serious embarrassment in the way of a satisfactory agreement with Great Britain. It rests in the differing views of the two Governments in respect to the obligatory character of what we call the Law of Nations. Our Courts and Government have acknowledged under that name the existence of an external body of principles and rules obligatory on us in our international relations, which have obtained their authority prior to and without our express national sanction, and which we must recognize and obey as a member of the family of nations. The English, on the contrary, deny the authority of these principles and rules until they are expressly adopted in Great Britain, either by legislation or by decisions of their courts. That is to say, international law must be expressly converted into the form of municipal law before it will be binding upon the British Government. A remarkable instance of this occurred in the time of Queen Anne, when process was allowed against the Russian Ambassador by her courts in violation of the most ancient of international rules; and although Parliament was promptly called on to adopt the rule of extraterritoriality, and humble apologies were made, the breach between the two governments because of the scandal was long continued.

Between our Republic and France very serious discussions have arisen during the century, but none which have been beyond the power of diplomacy to adjust. Once indeed (1880) the intervention of a friendly power was agreed upon merely for the appointment of a third commissioner upon a board for the adjustment of claims. There are no boundary questions between the two dominions, separated by an ocean, and no probable disputes except those which may arise upon the interpretation of

international laws or treaties, or for damages to neutral interests in war. It is therefore with pleasure that we recall the unanimous passage by the House of Deputies of the French Parliament, on the 8th of July, 1895, of the following resolution:

"Le Chambre invite le gouvernement à négocier le plus tôt possible la conclusion d'un traité d'arbitrage permanent entre la Republique Française et la Republique des Etats-Unis d'Amérique."

A previous resolution of like tenor had been approved by all the Bureaux of the Chamber in 1888, but not forwarded to a vote. We are justified, therefore,, in assuming that French opinion has reached a point as advanced as our own in favor of permanent provisions for arbitration between these two countries, each of which would revolt at the thought of sundering their ancient and long unbroken friendship.

In regard to the line which separates the questions which may be submitted to arbitration from those which nations must reserve for their own independent decision, the determination must be left to those experienced men who have reached the third degree in international diplomacy. That there are questions of national honor and safety which no self-respecting government will agree in advance to submit to the final decision of a third party, I fully admit. The utmost that can be expected in such cases is an agreement to have recourse to the friendly mediation of a third power, before a resort to hostilities. This proceeding would in most instances be effective in bringing both to an understanding.

From our point of view these two groups of nations can at any time proceed to the negotiation of a treaty providing for the reference to arbitration of all differences hereafter arising between them, which shall not be adjusted through ordinary diplomatic agencies, and so far as they fall within the classification which should be set forth in a special article. They would of course provide for the observance by each in good faith of the decision of the arbitrators. For example, the following classification might be offered as a basis: (*a*) Conflicting claims of territorial boundary lines or jurisdiction. (*b*) Conflicting claims of marine jurisdiction, or touching the rights or exemptions of vessels, persons or property on the high seas or in the ports or waters of either nation, whether arising under international law or

treaty. (*c*) All claims for damages made by one government against the other on account of wrongs done to the citizens or subjects of either within the jurisdiction of the other, or to the property of either government, or of its citizens or subjects, in respect to which the government is responsible, or alleged to be responsible. (*d*) All disputes of law or fact arising under the provisions of any treaty then in force between the two nations. (*e*) Differences arising between them in respect to a refusal or violation of diplomatic or consular rights and privileges, alleged by one government against the other. The arbitral tribunal to decide the extent of its conferred jurisdiction.

It is greatly to be desired that a clause should be also agreed to, providing that in all other cases whatever there should be a resort to the mediation of a friendly power or powers before having recourse to hostilities. This alone would be an inestimable contribution to the cause of peace. This space for reflection, this time for the cooling of temper on the part of both ministers and people, this invited intervention of an impartial third party, would in most cases open the road to reconciliation. Even on questions of national honor and dignity an offending or offended government could afford to accept as the award of a court of honor what it could not itself propose. This yielding to the advice of a third and friendly power, instead of to the demands of an ungracious adversary, often saves the points of both honor and safety to the yielding government.

In respect to the differences so subjected to arbitration, they should renounce the right of war against the party conforming to the rule of arbitration, each party retaining the right to enforce the arbitral decrees. Another article would provide for the organization of the court of arbitration. A third might extend the agreement to include all other differences which do not in the judgment of either government involve its safety or its honor.

An international convention embracing these provisions would notably inaugurate that era of peace for which the overburdened nationalities of the Christian civilization have been waiting. There are some groups of nations which will not yet accept it. But so far as concerns the two groups under consideration, there is no serious obstacle in the way of either nation proceeding now by a special commission, or otherwise, to settle the terms of such a convention.

Compulsory Mediation.

The proposed provision for mediation in all cases before an act of hostility is not new to diplomacy. It has already been once provided for in a general treaty now in force. In the Congo Conference, held in Berlin in 1884-5, I proposed in behalf of the United States the acceptance by the fourteen powers assembled in that Conference of the principle of arbitration for all differences which might arise between them in respect to their Central African possessions. This proposition obtained the adhesion of nearly all the powers, including the very active support of Germany and Italy. France stood resolutely against it. Its prolonged discussion finally resulted in a compromise article (the twelfth of the treaty) which was as far as the French plenipotentiary was willing to go. This article provides that where serious differences between the signatory Powers shall arise on the subject or within the limits of these territories, the Powers involved shall resort to the mediation of one or more friendly governments before appealing to arms. They reserve to themselves as an alternative the option of arbitration. This result—compulsory mediation, optional arbitration—was a great gain to the principles of peace. It is a remarkable fact that Mohammedan Turkey accepted arbitration for Africa, while Christian France and Portugal at that time repudiated it.

During this generation, at least, no powerful nation will bind itself to arbitration much beyond the limitations which have been here generally indicated. For unknown questions, for some unknown conditions of the future, the dreadful right of war will be, and for the present ought to be, retained for the security of that independence, liberty and civilization which have so largely owed to it their modern progress and security. We shall still look to the polished points of our bayonets to reflect on us the desired sunshine of Peace.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL LAW AND NAVAL COURTS.*

By Charles H. Lauchheimer, First Lieutenant, U. S. Marine Corps.

Gentlemen:—The subject assigned me by the President of this College—Naval Law and Naval Courts—is one of such magnitude that it has been quite a task to condense into two lectures such features as I trust will be not only interesting but at the same time instructive to the student of that branch of our profession which, I regret to state, has hitherto been neglected and not given that degree of attention which its importance merits. A knowledge of naval law is, in my humble opinion, necessary to the naval officer who desires properly to perform the functions of his office, no matter what his rank or position may be. I have designed to preface my remarks with a brief history of naval law, and then to discuss the various tribunals which by statute are in force in the naval service, and which are known as Naval Courts.

Naval Law.

Naval law is synonymous with military law, and in its restricted sense is the specific law governing the Navy as a separate community. Ordinarily and for all practical purposes military and naval law may be considered under the general head of military law, and hereafter in these lectures whenever the term military law is used, it is to be understood as including naval law, *i. e.*, I will speak of that branch of the law which governs the Army, Navy, and the Militia when called into active service, but with special reference, however, to that branch thereof which pertains to the naval service.

* Address delivered at the Naval War College, Newport, R. I., August 28 and 31, 1896.

At the very beginning may I ask your attention to the distinction between military and martial law, the latter being operative only in time of war or like emergency when the military government supersedes the civil, and has as its object the control of the respective armies and of those violating, in respect to said armies, the laws of war; whilst military law, as before stated, is the specific law governing the Army and Navy, in time of peace as well as war.

Historically considered, military law antedates the Constitution, but as, however, all law, both public and private, began to exist or operate anew from the time of this instrument, it is customary to designate the Constitution as the source of all military law. We have, therefore, only to look at that document to find the specific provisions which may be regarded as the source or sanction of our present military law and its jurisdiction, and they are as follows:

Congress is empowered "to define and punish offenses against the law of nations;" "to declare war, grant letters of marque and reprisal and make rules concerning captures on land and water;" "to raise and support armies;" "to provide and maintain a navy;" "to make rules for the government and regulation of land and naval forces;" "to provide for calling forth the militia to execute the laws of the Union, suppress insurrections and repel invasions;" "to provide for organizing, arming and disciplining the militia, and for governing such part of them as may be employed in the service of the United States;" and generally "to make all laws which shall be necessary and proper for carrying into execution the foregoing powers" (*i. e.*, those set forth as well as others in the same section), "and all other powers vested by this Constitution in the Government of the United States or in any department or officer thereof." The President, as Commander-in-Chief of the Army and Navy of the United States and of the militia of the several States when called into actual service of the United States, is empowered to appoint (in conjunction with the Senate) and to commission the officers of the Army and Navy, etc., and it is also made his duty "to take care that the laws be faithfully executed."

And perhaps the most important of all, the Fifth Amendment, which provides that "No person shall be held to answer for a

capital or otherwise infamous crime unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the militia when in actual service in time of war or public danger."

Military law, which as I have before stated, is operative both in peace and in war, is both written and unwritten, just as is the civil law.

The written military law, so far as it applies to the Navy, is founded upon the statutory code known as the Articles for the Government of the Navy; other statutory provisions relating to the Navy; the Navy Regulations, and general and special orders issued by the Department.

The unwritten military law, while it has derived from the common law certain of its precepts and doctrines, has nevertheless an unwritten law distinctively its own, which consists of certain established principles and usages peculiar or pertaining to the naval service, and which, from their immemorial usage, are as well known to the officers of the service as are the doctrines of the common law to the lawyer. The customs of the service are recognized as binding on courts-martial, and in fact, by the act entitled "An act for the government of the Navy of the United States," approved March 2, 1799, it is provided that "every commander-in-chief and captain, in making private rules and regulations, and designating the duties of his officers, shall keep in mind also the customs and usage of the sea service most common to our nation." This, in effect, provides a statutory enactment for the recognition of the unwritten military law.

In our service the unwritten military law is very meagre, for from time to time the customs of the service have been embodied in the Navy Regulations, and have thus become part of the written military law. Still there does exist an unwritten military law, and perhaps it will not be out of place to state here that in order that a particular usage or custom may have the force of unwritten law, it must fulfill certain conditions, the most important of which are that it must be uniform, well defined, and equitable; must be of long standing; must be certain and reasonable, and not in conflict with statute or constitutional provisions, and must be so long continued and notorious that all persons concerned may be presumed to have knowledge of it.

It must also refer to a subject upon which the written law is silent, and must not be prejudicial to discipline. It is essential that all these conditions be present in order that the custom or usage may come within the category of the unwritten law.

Naval law, therefore, as we find it, is principally statutory law, or regulations made in conformity therewith, and the customs of the service.

With this short review of what naval law is, we will pass to the consideration of those tribunals by which it is administered, *i. e.*, courts-martial and courts of inquiry, and will first trace briefly the origin and history, the nature as a legal tribunal, the constitution, the composition and jurisdiction of courts-martial.

Origin and History.

Some form of tribunal for the trial of military offenses seems to have existed since the early history of armed forces. In Rome, justice was administered by the *Magistri militum*, and especially by legionary tribunes either as sole judges or with the assistance of councils. Among the early Germans, in times of peace the courts were held by the counts, assisted by the freemen, but in time of war by the duke or military chief, who generally delegated this authority to the priests who accompanied the army; later, courts of regiments were formed, and the matter was left to the colonel of the regiment, who could, however, delegate his authority to an officer by investing him with the staff or mace called the *regiment* as the emblem of judicial authority. Courts-martial proper (Militär-gerichte), however, probably date from the Articles of War promulgated in the time of Frederick III, 1487; they (the courts) were specifically provided for in the penal code of Charles V, although more accurately defined in the articles of Maximilian II, of 1570. In France, courts-martial (conseils de guerre) were first established by the ordinance of 1655. Previous to this, military prisoners were subjected to the jurisdiction, successively of the Mayor of the Palace, the Grand Seneschal, the Constable, and the Provost-Marshal. In England, the original of the modern court-martial is seen in the "King's Court of Chivalry," or as it was also called, the "Court of Arms" or the "Court of Honor," of which the judges were the Lord High Constable and the Earl Marshal. These officials also formed part of the "Aula Regis"

of William the Conqueror, but it was not until the subdivision of that tribunal into separate courts by Edward I, in the latter part of the 13th century, that the Court of Chivalry had an independent existence; as thus constituted its jurisdiction was an extended one, applying to matters both civil and criminal, and touching "all matters of honor and arms," "pleas of life and member arising in matters of arms and deeds of war," "the rights of prisoners taken in war," and also to "offenses and miscarriages of soldiers contrary to the rules of the army" and to "civil crimes and matters of contract." Owing to the extended jurisdiction accorded to this tribunal, it gradually encroached upon the common law courts and consequently it was, by various acts of parliament, gradually shorn of much of its power, and although never specifically abolished by statute, it had, nevertheless, before the English Revolution, practically ceased as a military tribunal. Subsequent to the decadence of the Court of Chivalry and preceding the first mutiny act, justice was administered by martial courts, or councils, convened in accordance with the articles of war then in force. During the reign of the Tudors and Stuarts and prior to the Petition of Right, military law, as administered, resembled martial law rather than military law of modern times, as civilians were tried by courts-martial and even the death penalty inflicted upon them in cases where the law of the land did not authorize such jurisdiction or punishment. Finally, by the mutiny act of 1689, the death penalty was prohibited except in certain cases and the Sovereign (for the first time by legislative authority) was expressly empowered to grant commissions to convene courts-martial, and this authority was gradually increased and enlarged by subsequent mutiny acts and Articles of War, and finally established and defined by the Army Act of 1881.

The English military tribunal having been transplanted to this country prior to our Revolutionary War, was recognized and adopted for the army by the Continenal Congress in the Articles of War of 1775, in which the different kinds of courts were distinguished and their composition and jurisdiction defined. These articles were amended by those of 1776 and 1786. The first act of the Continental Congress tending to the establishment of rules and orders for the Navy of the United Colonies was passed November 24, 1775. This was subsequently

modified from time to time, and finally enacted into the first act for the better government of the Navy of the United States, approved April 23, 1800. Since then articles have, from time to time, been enacted, those referring to the Army being known as the "Articles of War," and those referring to the Navy as "Articles for the Government of the Navy." The articles under which naval courts now derive their power and jurisdiction are contained in the act approved July 17, 1862, and known as Section 1624 of the Revised Statutes.

Nature of the Court-Martial as a Legal Tribunal.

By Article 1, Section 8, of the Constitution, Congress is empowered "to make rules for the government and regulation of the land and naval forces," and in pursuance of this authority it has enacted "Articles for the Government of the Navy," which contain provisions relating to the organization, jurisdiction, and other features of naval courts-martial. The Fifth Amendment, before referred to, is also frequently considered as the source of authority for courts-martial, for, as stated by Attorney General Cushing (6th Opin., 425), this amendment "expressly excepts the trial of cases arising in the land or naval service from the ordinary provisions of law," and, as was decided in the case of Trask vs. Payne, (43 Barb., 569) "this provision practically withdraws the entire category of military offenses from the cognizance of the civil magistrate, and turns over the whole subject to be dealt with by the military tribunals." This decision has only recently been confirmed by the Supreme Court in the naval case of Johnson vs. Sayre (158 U. S., 109).

Another authority for the creation of courts-martial is attached to the constitutional function of the President as commander-in-chief of the army and navy.

Courts-martial of the United States have a legal sanction of equal importance with the federal courts; still, unlike the latter, they are not a portion of the judiciary of the United States, and are not, therefore, included among the "inferior courts" which Congress "may from time to time ordain and establish." In the leading case of Dynes vs. Hoover (20 Howard, 79), the Supreme Court held, referring to the provisions of the Constitution before referred to, that "these provisions show that Congress has the power to provide for the trial and punishment of military and

naval offenses in the manner then and now practiced by civilized nations, and that the power to do so is given without any connection between it and the 3d article of the Constitution defining the judicial power of the United States; indeed, that the two powers are entirely independent of each other." Again, in *Ex parte* Vallandigham (1 Wallace, 253), the court held the authority exercisable by a military commission though "it involves discretion to examine, to decide and sentence, is not judicial in the sense in which judicial power is granted to the courts of the United States." From this it appears that courts-martial, not belonging to the judicial branch of the Government, must pertain to the executive branch, and they are, in fact, *instrumentalities of the executive*, provided by Congress in order to enable him, as Commander-in-Chief, properly to command the Army and Navy and enforce discipline therein, and utilized under his orders or those of his authorized military representatives. Being a purely executive agency, which is designed for military uses, called into existence by a military order and, when its work is completed, dissolved by a similar order, it follows that the court-martial, as compared with a civil tribunal, is transient in its duration, and summary in its action; for, as stated by the Supreme Court in *Ex parte* Milligan (4 Wallace, 123), "the discipline necessary to the efficiency of the Army and Navy required other and swifter modes of trial than are furnished by the common law courts."

And, as stated by Colonel Winthrop, courts-martial, unlike the superior courts of record, have no fixed places of session, no permanent office or clerk, no inherent authority to punish for contempt, no power to issue a writ or judicial mandate, and their judgment is simply a recommendation, not operative until approved by a revising power. It consequently belongs to the class of minor courts of special and limited jurisdiction and scope, where competency cannot be extended by implication, in favor of whose acts no intendment can be made when their legality does not clearly appear, and which cannot transcend their authority without rendering their members trespassers and amenable to civil action.

Furthermore, as the court-martial is no part of the judiciary of the country, its proceedings are not subject to be directly reviewed by a Federal Court either by *certiorari*, *writ of error*, or

otherwise, nor are its judgments or sentences subject to be appealed from to such tribunal. It is not only the highest but the only court by which a military offense can be heard and determined, and a civil or criminal court has no more appellate jurisdiction over offenses tried by court-martial—no more authority to entertain a rehearing of a case tried by it, or to affirm or revise its finding or sentence as such—than have the courts of a foreign nation.

In the case of Dynes vs. Hoover, above cited, the court held that the duly confirmed sentence of a court-martial "is altogether beyond the jurisdiction or inquiry of any civil tribunal whatever," and that with reference to the legal sentence of competent courts-martial "civil courts have nothing to do, nor are they in any way alterable by them," for "if it were otherwise the civil courts would virtually administer the rules and articles of war irrespective of those to whom that duty and obligation have been confided by the laws of the United States, from whose decisions no appeal or jurisdiction of any kind has been given to the civil magistrate or civil courts."

In the case of Wales vs. Whitney (114 U. S., 564), which was a proceeding instituted against the Secretary of the Navy for the discharge on *habeas corpus* of Medical Director Wales, the Supreme Court held that "no Federal Tribunal has any appellate jurisdiction over the naval court-martial, nor over offenses which such a court has power to try," and also that no such tribunal "is authorized to interfere with a court-martial in the performance of its duty by way of a writ of prohibition or any order of that nature."

The writ of prohibition above referred to is resorted to to prevent the doing of an act not yet performed or completed, and has never been granted in a military case in this country, nor had one been applied for in any case pending before a naval or military court-martial before the case of Paymaster General Smith of the Navy, in which, in view of the ruling of the Supreme Court in the case of Wales vs. Whitney, above referred to, the writ was refused by the Supreme Court of the District of Columbia, September 25, 1885. The decision of the Supreme Court of the District of Columbia was subsequently affirmed by the Supreme Court of the United States (116 U. S., 167).

The appeal from courts-martial is vested in the President or

Secretary of the Navy, the latter being assisted and advised by the Judge Advocate General of the Navy.

Although, as above stated, the civil courts have no right of entertaining an appeal from courts-martial, yet the writ of *habeas corpus* may be awarded to a prisoner claiming to be illegally detained under trial or sentence of court-martial, and in this proceeding the legality of the action of the court, *i. e.*, whether it was legally constituted, whether it had jurisdiction, and whether the sentence is one it was authorized to inflict, may be inquired into, but the action must have been absolutely illegal and void in law, before the federal courts will grant relief, for, as held by the Supreme Court in *Ex parte* Mason (105 U. S., 697), it, the Supreme Court, "has no power to review the judgment of courts-martial" and that it cannot, upon *habeas corpus*, discharge a person under sentence of court-martial, "if the court had jurisdiction to try the offender for the offense with which he was charged, and the sentence was one which the court could, under the law, pronounce." In *Ex parte* Reed (100 U. S., 23) the Supreme Court held that "a writ of *habeas corpus* cannot be made to perform the function of a writ of error. To warrant the discharge of a petitioner, the sentence under which he is held must be not only erroneous and voidable, but absolutely void." In Wales vs. Whitney (114 U. S., 575), it is held that even when the court-martial had in fact no jurisdiction, the power of the civil tribunal on *habeas corpus* "extends no further than to release the prisoner. It cannot remit a fine, or restore to an office, or revise the judgment of the military court." It was further held in this case that when the officer's arrest simply confined him to the limits of the city of Washington it was not such physical restraint as to be a subject of discharge on *habeas corpus*.

Inasmuch as there is no appeal to the civil courts, the judgment of a court-martial is, within its scope, absolutely final and conclusive. Its sentence, if *per se* legal, after it has received the necessary official approval, cannot be revoked or set aside, and it is only by the exercise of the pardoning power that it can, if not as yet executed, be rendered in whole or in part inoperative.

Although, as above stated, the court-martial is but an instrumentality of the executive power, having no connection with the judiciary, it is, nevertheless, within its field of action, as fully a court of law and justice as is any civil tribunal. As a

court of law it is bound, like any other court, by the fundamental principles of law, and in the absence of a special provision it is to be governed in the matter of evidence by the rules of the common law courts. As a court of justice it is to decide between the United States and the accused, according to the evidence, the rules for the government of the Navy, and its own conscience.

The old-time designation of the court-martial as a "court of honor," although not often used, is still as applicable as it was formerly, because a court-martial punishes dishonorable conduct when it affects the reputation or discipline of the Navy; as, for example, a court-martial can try an officer for "conduct unbecoming an officer and a gentleman," which is an offense not cognizable in any other court of the land; and even though it does proceed on the ground of being a court of honor, it is, nevertheless, bound in its procedure by the rules of criminal pleading and evidence.

One of the greatest distinctive peculiarities of a court-martial is its dual function of judge and jury; for in its capacity of jury it takes the oath, is liable to be challenged, hears and weighs the evidence, finds the accused guilty or innocent, and is liable to be recalled to revise its proceedings; in its capacity of judge it arraigns the accused, hears and determines questions as to its own jurisdiction, hears and decides upon the competency of pleadings and testimony, sentences the accused, and finally adjourns.

In the case of the United States vs. Clarke (96 U. S., 40) the Supreme Court held that a court-martial is strictly a criminal court, and in fact it has no civil jurisdiction whatsoever; *i. e.*, it cannot enforce a contract, collect a debt, award damage from one to another, for all the fines which it does award inure to the Government.

Constitution of General Courts-Martial.

The authority to constitute general courts-martial is found in Article 38 of the Articles for the Government of the Navy, which provides—

> General courts-martial may be convened by the President, the Secretary of the Navy, or the commander-in-chief of a fleet or squadron; but no commander of a fleet or squadron in the waters of the United States shall convene such court without express authority from the President.

This article plainly designates the persons authorized to convene courts-martial, and in conformity with the concluding paragraph, it is the custom of the Navy Department to request of the President, whenever an officer is ordered to command the North Atlantic or Pacific Stations, that authority be granted him to convene general courts-martial when in the waters of the United States, and this request is invariably granted.

Composition of General Courts-Martial.

The law which refers to the composition of general courts-martial is found in Article 39 of the Articles for the Government of the Navy, which provides—

> A general court-martial shall consist of not more than thirteen nor less than five commissioned officers as members; and as many officers, not exceeding thirteen, as can be convened without injury to the service, shall be summoned on every such court. But in no case, where it can be avoided without injury to the service, shall more than one-half, exclusive of the President, be junior to the officer to be tried. The senior officer shall always preside and the others shall take place according to their rank.

From this it will be seen that only commissioned officers are eligible to membership of general courts-martial, the detailing of a warrant officer, cadet, petty or non-commissioned officer when the person to be tried is one of such grades, which, although authorized in European codes, has never been authorized by our law.

The only class of commissioned officers in time of peace who are exempt from this duty are retired officers who, by Section 1462 of the Revised Statutes, are not to be employed on active duty except in time of war.

The question is often asked, who are commissioned officers? and the answer is, all those who have duly received and accepted commissions appointing them to offices in the Navy. They are as much commissioned officers when they have temporary as permanent commissions. By a temporary commission I mean those which by the Constitution, the President is empowered to confer during a recess of the Senate to "expire at the end of the next session."

The question of the relative rank of members is an important one, and with a view of excluding, as far as practicable, officers

who are junior to the accused it is provided that "no officer shall, when it can be avoided, be tried by officers inferior in rank," but this provision is simply directory and it is a matter entirely within the discretion of the convening authority to decide upon not only the number of officers to constitute the court, but also the rank of its members; but as a general thing, if it can be avoided, juniors should not be placed on courts to try seniors. To show that the convening authority has had in view the provision of the law just referred to, the precept should invariably state that "no other officers can be summoned without injury to the service." Objections are often made because at least a majority of the court are not senior to the accused, and as a rule the court invariably and rightly fails to sustain such objection. The Attorney General has repeatedly decided that in no case is such an objection valid, as the discretionary power of the convening authority should in no case be abridged.

Officers of one branch of the service, as the Army, are not eligible to sit as members of a court to try offenders of the Navy, and *vice versa*, the only exception being in the case of Marine officers who, when detailed by order of the President for service with the Army may be associated with officers of that service for the trial of offenders in the Army, and *vice versa*. Under similar circumstances Army officers may be detailed as members of courts to try offenders in the Marine Corps, and it may even be that in such a case the court may be composed wholly of Army or Marine officers, for the trial of persons of the Marine Corps or Army respectively.

In the case of courts-martial in the militia of the several States when called into active service, Section 1658 of the Revised Statutes provides that "courts-martial for the trial of militia shall be composed of militia officers only." The proceedings of those courts are not reviewable by the civil courts. There is no similar provision of law with regard to the naval militia recently organized, still by inference, and until there be some express provision of the law, it would follow that they should also be tried only by their own officers, that is, by a court composed of officers not necessarily of the same State, but by officers of the militia of any of the States.

Number of Members.

Article 39 of the Articles for the Government of the Navy provides *inter alia* that—

> A general court-martial shall consist of not more than thirteen nor less than five commissioned officers as members; and as many officers, not exceeding thirteen, as can be convened without injury to the service shall be summoned on every such court . . .

From this it is seen that the number of members is to be not more than thirteen nor less than five, and that at least the latter number is necessary to constitute a quorum for trial and judgment. Although five is all that is necessary, yet it is customary to detail at least seven members on a court so that there will be a working quorum in case of illness or absence of any member. When but five officers are ordered as members of a court the other four may deliberate on the challenge of a member, and if it is sustained may meet and adjourn until the convening authority is heard from. In the same manner when at the outset a member is absent by reason of illness or for any other cause, the other four may meet and adjourn, but at least five must be present and sworn to constitute a court for the trial, and at least five must be present during the entire trial.

When there are more than five members originally, the absence of one or more members does not affect its competency to proceed so long as five remain. As a familiar illustration,—a court which consisted of thirteen members may be reconvened for a revision of the sentence, and five members may so reconvene, revise the sentence, and the revised sentence is the sentence of the court. As before stated, the number—within the limits of the law—to be detailed on a general court-martial is a matter of discretion with the convening authority, and from his decision there is no appeal. This point was decided by the Supreme Court in 1827, in the case of Martin vs. Nutt.

When a general court-martial is reduced below five members it need not necessarily be dissolved, but additional members may be detailed, and when they have been sworn and taken their seats its power as a court is restored, and it may legally proceed with the trial, but the accused is, of course, entitled to challenge, and the new member or members to have all the proceedings read over to them, the testimony of the witnesses to be read in

the presence of the witnesses, and the new member or members to ask such questions as they may desire; in fine, the entire proceedings are gone over again for the benefit of the new members in order that they may be perfectly *en rapport* with them.

Jurisdiction of General Courts-Martial.

In considering the question of the jurisdiction of general courts-martial we will divide the subject into four heads:

1. The place over which such jurisdiction extends or within which it may be exercised.
2. The period of time to which its exercise is limited.
3. The persons who are subject to it.
4. The offenses which it embraces.

(1) The jurisdiction of general courts-martial is co-extensive with the territory of the United States, so that no matter in what part of the United States the offense was committed, a general court-martial has jurisdiction, and in this respect it will be noted that it is different from civil courts whose jurisdiction is limited to offenses committed within certain prescribed limits of territory. Vessels of war having the right of exterritoriality, no matter where they are, they are part of the United States for this purpose. It may be well to state here that a general court-martial must never, in time of peace, be convened on foreign territory, for, if so, the proceedings are absolutely void *ab initio*. In the case of *Ex parte* Milligan (4 Wallace, 141), the Supreme Court held that "wherever our Army or Navy may go beyond our territorial boundaries, neither can go beyond the authority of the President or the legislation of Congress." This jurisdiction extends to offenses committed by persons in the naval service when in occupation of insurrectionary districts, and it has been held that during the late war under such circumstances our Army was exempt from amenability to the local courts, and subject only to its own military tribunals. Both in times of peace and war, the jurisdiction of general courts-martial extends to offenses committed on shore by persons who are within the jurisdiction of the court.

In case of permission being granted by a foreign power, with which we are at peace, for our naval force to march across its territory, the jurisdiction of a general court-martial extends to offenses committed by officers and men within the lines or within

the neighborhood of the forces. This is based on the principle of exterritoriality under which, when the armies or navies of one nation are privileged to enter or pass through the country of another friendly nation, the laws of the former are deemed to continue to apply to its forces equally as if the same were within their own country. An illustration is afforded in the legal status of our army when permitted by Mexico to cross its territory in carrying on hostilities with the Indians.

In cases where an armed force of the Navy is induced to enter a foreign power's dominion with whom we are at peace and without its authority, the question as to the jurisdiction of a general court-martial is rather an unsettled one, but most of the authorities are of the opinion that it should have jurisdiction over naval offenses committed by any of its number on the foreign soil, provided the offender was, at the time the offense was committed, a member of an organized detachment under military command and discipline. But when the offender, even though in the service, is not on the foreign soil in his official capacity, as when he is there as a deserter, he would not be within the jurisdiction of a general court-martial. A case which covers this point is one in which an officer of volunteers was tried and dismissed the Army "for violation of the sovereignty of a friendly state, in arresting a deserter from the United States forces and bringing him away from within the boundaries of Canada."

(2) The question of the time within which a naval general court-martial has jurisdiction has recently been defined by the act of Congress approved February 25, 1895, and now known as Articles 61 and 62 of the Articles for the Government of the Navy, and which provide as follows:

ARTICLE 61. No person shall be tried by court-martial or otherwise punished for any offense, except as provided in the following article, which appears to have been committed more than two years before the issuing of the order for such trial or punishment, unless by reason of having absented himself, or of some other manifest impediment, he shall not have been amenable to justice within that period.

ARTICLE 62. No person shall be tried by court-martial or otherwise punished for desertion in time of peace committed more than two years before the issuing of the order for such trial or punishment, unless he shall meanwhile have absented himself from the United States, or by reason of some other manifest impediment shall not have been amenable to justice within that period, in which case the time of his absence shall

be excluded in computing the period of the limitation; *Provided,* that said limitation shall not begin until the end of the term for which said person was enlisted in the service.

The 103d Article of War in the Army is similar to Article 61, first above quoted, and has been in force for years. It was at one time questioned whether the provision was a prohibitory restriction upon jurisdiction, or merely as providing a defense to be taken advantage of by special plea. In 1820 Attorney General Wirt held in construing the 103d Article that the limitation prescribed by the article was *absolute* and could not be *waived;* he based his decision on the ground of public policy, being intended not solely for the benefit of the accused, but to secure that prompt and certain prosecution of military offenses which is essential to maintain the discipline of the service and that, therefore, it was to be regarded as prohibitory not only upon the United States but also upon the accused.

This opinion of Mr. Wirt has been affirmed by subsequent Attorneys General and has been strictly enforced in the Army as a rule of law to which no exceptions could be admitted. Even in the case where the accused requested to waive the restriction, the Judge Advocate General of the Army, and subsequently the Attorney General, held that it could not be done. The question has never arisen in our service, but the opinion of the Attorney General just cited would be applicable to a case in the naval service.

It may be proper to state that cases are cited in which the civil courts have, in effect, though not in terms, overruled the opinions of the Attorney General and directed that the statute of limitation of the military service, like those of the civil courts, shall act not as a restriction upon the court, but as a provision solely for the benefit of the accused of which he can take advantage by plea. It will be noted that the 62d Article makes an exception of the offense of *desertion,* which all authorities agree is a continuing offense, and as such that the statute does not begin to run until the termination of the term of enlistment; thus a man enlisting for three years, who deserts the third day of his enlistment, will be amenable to trial for a period of five years,—to wit, two years from the date of the expiration of the enlistment during which he deserted.

When an offense is by express provision of statute, or by

implication of its terms, restricted to a period of war, the jurisdiction of a general court-martial is similarly restricted, as for example, Section 1624 of the Revised Statutes, Article 5, being the Articles for the Government of the Navy, provides as follows:

> All persons who, in time of war, or of rebellion against the supreme authority of the United States, come or are found in the capacity of spies, or who bring or deliver any seducing letter or message from an enemy or rebel, or endeavor to corrupt any person in the Navy to betray his trust, shall suffer death, or such other punishment as a court-martial may adjudge.

This refers to the offense of the spy, and inferentially limits the trial by court-martial of a spy to the period of the duration of the war, so that if he is not brought to trial before the war is terminated, he cannot be tried at all. This rule was laid down *In re* Martin (45 Bart., 142, N. Y.). By the term "war" is meant not only foreign or international war, but also civil war, as well as a state of active hostilities, as with an Indian tribe. In considering this phase of the subject it may be well to define when war begins and ends. An international war will generally commence to exist upon a declaration of the same in some form by Congress under the clause of the Constitution which empowers that branch of the Government "to declare war." But such a declaration is not absolutely essential, as in case our country should be invaded by a foreign foe and before Congress could be assembled, then the Executive, as Commander-in-Chief, can call forth the troops to check the invasion, and this armed meeting and resistance would constitute the commencement of "war." In case of an insurrection or rebellion the commencement of war dates from the time when it has assumed such proportions that it becomes necessary to employ the armed forces of the United States to combat and suppress it. This action is promulgated in the form of a *proclamation* or order issued by the President.

The Constitution vests the authority to make treaties in the President, "by and with the advice of the Senate," and this practically gives to him the peace-making power so far as relates to a foreign war, so that in such a case the war ends with the date of the treaty or other agreement for the cessation of hostilities, and the date is announced by executive proclama-

tion. In case of *civil war*, a proclamation by the President announcing that the rebellion has been suppressed may be accepted as the authoritative date of the cessation of the state of war, and between these dates a status of war exists so far as the jurisdiction of courts-martial is concerned.

(3) With reference to the persons subject to the jurisdiction of general courts-martial, it may be stated that as the courts themselves owe their existence to statutory provision, they can exercise jurisdiction over such persons and offenses only as are constitutionally brought by statute within their cognizance, and these may be defined as follows:

The Navy of the United States, including the Marine Corps;

Certain civilians subject to naval discipline in time of war; and

The naval militia when called into service of the United States.

As especially applicable to the officers and men of the regular service, it may be well to state that, as to the period of their amenability, it is a well founded rule that it exists only during the period of service as an officer or enlisted man; *i. e.*, in the case of an officer his amenability commences from the acceptance of his commission and ends with his death, the acceptance of his resignation, or his dismissal. The same is true so far as enlisted men are concerned. In other words, so long as they are military persons they are subject to military jurisdiction.

There are a few exceptions to this rule when applied to enlisted men, and they are as follows:

(*a*). In case of desertion, which is a continuing offense, and as such continues up to the date of the expiration of the enlistment and from that date the statute of two years limitation begins to run.

(*b*). In case of an illegal enlistment which is voidable, if after enlistment the person so enlisted deserts, he may upon arrest be held, tried, and punished for his offense.

(*c*). As a general rule it has been laid down that if the military jurisdiction has once duly attached to military offenders prior to the date of the termination of their legal period of service they may be brought to trial by court-martial after that date, their discharge being meanwhile withheld. This generally applies to offenses committed the last day of the enlistment. A leading case in this respect is that of *In re* Walker, in which the Supreme Court of Massachusetts, in the case of a sailor in the

Navy, in adverting to the injurious results that might ensue were such a person permitted to plead guilty with impunity to grave offenses on the last day of his service, adds, "It is true that a seaman is not bound to do service after the expiration of his term of enlistment. But within that term he is bound to observe the rules and regulations prescribed by law for the government of the Navy, and is punishable for all crimes and offenses committed in violation of them during this term of service." In this case the petitioner was arrested or put in confinement and charges were preferred against him by the Secretary of the Navy before the expiration of his term of enlistment, and this was clearly a sufficient commencement of the prosecution to authorize a court-martial to proceed to trial and sentence, notwithstanding that the term of service had expired before the court-martial had been convened.

An exception to the question of amenability to trial by court-martial arises in the case of an officer or enlisted man who, although in the service, is duly absent from his station by leave of absence or furlough. It is apparent that these persons, during such time, cannot be guilty of a breach of discipline, neglect of duty or disobedience of orders (except one given in time of exigency to discontinue his leave), so if during such leave or furlough he commits an offense he will be amenable therefor to the civil tribunals without prior application to the military authorities. Of course, during leave of absence or furlough they can be tried by court-martial for "conduct unbecoming an officer and gentleman," "desertion," or any conduct tending to cast dishonor upon the service.

A prisoner of war in the hands of the enemy is also exempt, but of course can be tried for grossly contumacious language or injurious conduct towards another officer in the same situation.

Again, exceptions to the general rule that military jurisdiction terminates with discharge are those which are expressly provided for by statute as in the case of Articles 37 and 14, Section 1624 of the Revised Statutes, which provide—

ARTICLE 37. When any officer, dismissed by order of the President since 3d March, 1865, makes, in writing, an application for trial, setting forth, under oath, that he has been wrongfully dismissed, the President shall, as soon as the necessities of the service may permit, convene a court-martial to try such officer on the charges on which he shall have

been dismissed. And if such court-martial shall not be so convened within six months from the presentation of such application for trial, or if such court, being convened, shall not award dismissal or death as the punishment of such officer, the order of dismissal by the President shall be void.

The provisions of this article originally enacted during a period of war are applicable only to cases arising during war.

ARTICLE 14. If any person, being guilty of any of the offenses described in this article, while in the naval service, receives his discharge, or is dismissed from the service, he shall continue to be liable to be arrested and held for trial and sentence by a court-martial in the same manner, and to the same extent, as if he had not received such discharge or been dismissed.

In the Army there is express legislation contained in Sections 1361 and 2824 of the Revised Statutes, which makes amenable to trial and punishment by court-martial, under the rules and Articles of War, all prisoners under confinement in military prisons for offenses committed during said confinement, and also all persons admitted into the Soldiers' Home, who are subject to the Articles of War in the same manner as soldiers in the Army.

There is no express legislation on this point required in the Navy, as in our service prisoners are, whilst in confinement, still in the service, and, therefore, amenable in the same manner as though on active duty, and doubtless this rule would apply to inmates of the Naval Home, although I know of no case on record where an inmate of the Home has been tried by court-martial, as the Department dismisses from that institution all those who show by their conduct that they are unworthy of the benefits which the Home gives them.

The question of the amenability to trial of an officer or man (when duly dismissed, resigned, or discharged) for an offense committed prior to such discharge (and within two years) but not yet made the subject of charge or trial (except those just referred to) is a mooted one, and there appears to have been no adjudication on this point; but I believe the consensus of authority is to the effect that a subsequent reappointment or re-enlistment would not renew the jurisdiction for past offenses, but the same would be properly considered as finally lapsed.

The question is often asked whether an officer or enlisted man can at the same time be subject to the jurisdiction of a civil

tribunal and a court-martial for the same offense, and the answer is invariably in the affirmative, as has been decided by the courts in numerous adjudicated cases. Of course the civil and military courts take cognizance of different phases of the offense. Thus, an officer who has been tried and found guilty of larceny on shore, and sentenced to imprisonment, may properly be tried for conduct unbecoming an officer and a gentleman and dismissed the service. The plea of the constitutional privilege of not being twice placed in jeopardy for the same offense does not apply, as has been repeatedly held by the Supreme Court of the United States. An officer or man who has been tried by the civil authorities and acquitted may, nevertheless, be taken before a court-martial and tried and convicted of the military features of the offense.

Although there is no express legislation on the subject, I am of the opinion that the naval militia of the different States are, by analogy to the militia, amenable to trial by courts-martial (1) when employed in the federal service "in time of war or public danger," and (2) when they commit the offense of refusing to be so employed.

The question as to when the militia were to be legally regarded as in the employment of the United States was decided by the Supreme Court in the case of Houstin vs. Moore to be "the formal muster into the United States service at the place of rendezvous," and the amenability continues until "discharged by proclamation of the President."

The amenability of the militia for refusal to comply with the call of the President is found in the Act of 1795, which was repeated in the Act of 1861, and found in Section 1649 of the Revised Statutes. What sort of a court-martial should try such an offender has been decided by the Supreme Court in the case of Houstin vs. Moore (5 Wheaton, 1, 25, 64-66), to be one composed of militia officers. This ruling has been subsequently affirmed by the Supreme Court in the case of Martin vs. Mott (12 Wheaton, 19, 34).

In the case last above cited the court held that the jurisdiction of the court-martial to try was not restricted to the period of war or public danger, but that the offender could be tried subsequent thereto.

Civilians Subject to Military Discipline in Time of War.

In the Navy the question of the amenability of civilians to naval discipline and trial by court-martial in time of war will arise much less frequently than in the Army, and perhaps not at all. Still as such a case might arise in landing parties, as well as naval forces serving on shore in detached parties, I have thought it best to give a brief outline of their amenability as applied to the Army.

The 63d Article of War provides:

Article 63. All retainers to the camp, and all persons serving with the armies of the United States in the field, though not enlisted soldiers, are to be subject to orders, according to the rules and discipline of war.

This provision, coming with slight modification from the original code of 1775, which in turn was taken from the British articles of similar import, has been construed to make the persons coming within its description subject not only to the orders for the government and discipline of the command to which attached, but also to trial by court-martial for violation of the military code. It is but proper that these people, receiving the protection of the government, should be amenable to its rules and regulations.

The term "retainers to the camp" includes (1) officers' servants (when not enlisted); (2) camp followers attending the Army, but not in the public service. The camp followers are sutlers and their employés, newspaper correspondents, telegraph operators, etc.

The term "persons serving with the armies in the field" has been construed to mean those civilians who are in the employment and service of the Government. It refers to clerks, teamsters, laborers, hospital officials and attendants, interpreters, guides, scouts, as well as men employed on transports and military railroads.

Of course it has always been held that this article should be strictly construed, as it creates a certain military jurisdiction over a limited class of civilians. During our late war, however, numerous cases of this character occurred in the Army, and the jurisdiction of the court was invariably sustained so long as the civilians were "actually serving with the Army," and so long as the proceedings were instituted during the "*status belli.*"

Articles 45 and 46 of the Articles of War provide—

ARTICLE 45. Whosoever relieves the enemy with money, victuals, or ammunition, or knowingly harbors or protects an enemy, shall suffer death, or such other punishment as a court-martial may direct.

ARTICLE 46. Whosoever holds correspondence with, or gives intelligence to the enemy, either directly or indirectly, shall suffer death, or such other punishment as a court-martial may direct.

The word "whosoever" applies with equal force to civil and military persons, as has repeatedly been held by the courts after lengthy opinions on the subject.

Sections 4 and 5 of Article 4 of the Articles for the Government of the Navy provide—

The punishment of death, or such other punishment as a court-martial may adjudge, may be inflicted on any person in the naval service:

FOURTH. Who gives any intelligence to, or holds or entertains any intercourse with, an enemy or rebel, without leave from the President, the Secretary of the Navy, the commander-in-chief of the fleet, the commander of the squadron, or, in case of a vessel acting singly, from its commanding officer;

FIFTH. Who receives any message or letter from an enemy or rebel, or, being aware of the unlawful reception of such message or letter, fails to take the earliest opportunity to inform his superior or commanding officer thereof.

It will be noted that our articles are differently worded from those of the Army last above referred to, inasmuch as the Army articles refer to "whosoever" does the things therein mentioned, whilst in the Navy the words "any person in the naval service" are used. I have been unable to find any decision of the courts on this point, but I am of opinion, in view of the decisions in the Army, that the courts would liberally construe these articles so as to include those civilians who are attached to the Navy and who would for this purpose be in the "*naval service.*"

As in the other sections above quoted the operation of these sections must be understood to be limited to acts committed on the theater of war or within the scope of martial law, during the *status belli.*

OFFENSES WITHIN THE JURISDICTION OF COURTS-MARTIAL.

With reference to offenses coming within the jurisdiction of courts-martial, it may be laid down as a general rule that the offenses cognizable are those made so by the Articles for the

Government of the Navy or by other statutes. The Articles for the Government of the Navy define not only the specific offenses which are punishable by courts-martial, but also those which are embraced under a general description. Thus the first clause of Article 8, after mentioning falsehood, drunkenness, theft, et cetera, makes the omnibus description "or any other scandalous conduct tending to the destruction of good morals." Again, Article 22 states, "All offenses committed by persons belonging to the Navy which are not specified in the foregoing articles, shall be punished as a court-martial shall direct," and under this general description are classed such offenses as "conduct to the prejudice of good order and discipline" and "conduct unbecoming an officer and gentleman." It is proper when the articles expressly make an offense cognizable to lay the offense under that article, but when in the opinion of the convening authority, an offense has been committed which is serious enough to be tried by a court-martial, and which does not come within the specific enactment of any of the articles, it may properly be charged as "conduct to the prejudice of good order and discipline," "scandalous conduct tending to the destruction of good morals," or "conduct unbecoming an officer and gentleman."

Again, under the head of "specific offenses," we find not only those which are crimes only in the military law, but also those which are crimes in the military as well as the civil law.

The former are desertion, absence without leave, mutiny, disobedience of orders, disrespect to superior officer, sleeping on post, et cetera; the latter are larceny, crimes committed with violence, embezzlement, frauds, et cetera. It must be remembered, however, that both of these forms of offenses are both criminal and military, they are criminal, because the jurisdiction of courts-martial is criminal, and military because all offenses committed by officers and enlisted men and cognizable by courts-martial are necessarily military offenses. But though they are both criminal and military, there is this further distinction as to purely military offenses, *i. e.*, the jurisdiction of the court-martial is *exclusive*, while of the others, except in time of war in a region under martial law, the jurisdiction is *concurrent* with the civil tribunals.

The specific offenses are further subdivided into those which

are peculiar to and punishable only in time of war, and those which may be committed and punished at any time, either in war or peace.

Another feature of the offenses cognizable by courts-martial is that although of a criminal character the common law distinction between felonies and misdemeanors does not prevail. They are neither the one nor the other, but simply military crimes. At common law a felony was a crime entailing a forfeiture of lands or goods, but in our country it is used to indicate a crime for which the punishment is either death or imprisonment in the penitentiary. A misdemeanor is any crime less than a felony.

At common law there is the distinction between principals and accessories, *before* and *after* the fact, but no such distinction prevails in military law, and all accused persons are treated as independent offenders, and although it sometimes happens that persons may be jointly charged and tried, as for mutiny, and each may be guilty of distinct participation calling for punishment, yet in the eyes of the military law all are principals.

Another distinction to be noted is that in courts-martial there are no statutory grades or degrees of offenses, as for instance there are no grades of desertion, mutiny or cowardice, although the circumstances of such offenses may differ greatly in criminality and may call for very different degrees of punishment.

A point which may be adverted to in this connection is that the jurisdiction of the greater offense carries with it that of the lesser offense. Thus, a man charged with desertion of which the court has jurisdiction, implies also jurisdiction of the lesser offense of "absence without leave"—so also murder and manslaughter, or robbery and larceny. The principle upon which this rests is that the court in trying the crime charged has jurisdiction of any minor criminal act recognized as an offense by law which it contains or involves.

Rules for Drawing up Charges and Specifications.

At this time whilst we are considering the offenses which come within the jurisdiction of general courts-martial it may not be amiss to invite your attention to the question of the charges and specifications, the instrument by which the offense or offenses are brought within the jurisdiction of the court.

The charges and specifications in military law are similar to the indictment in a criminal case in civil law, and as this is the groundwork upon which the superstructure is built, it is evident that too great care cannot be exercised in having them legally and technically correct in order that the technical demurrer or plea may properly be overruled by the court. I have, therefore, to ask your attention whilst I give a few fundamental rules bearing upon the manner of framing charges and specifications.

The officer ordering the court, after assuring himself that the offense is one which should be heard by a general court-martial, should carefully digest the alleged matter so as to have it fully in hand.

The first point to be decided is the gravamen of the offense, in order that it may be properly classed under one of the Articles for the Government of the Navy. This decided, the next point to be considered is the number of specifications, and the specific matter to be charged in each specification, for care must be taken that all the rules of pleading are complied with, so that a demurrer, if offered, cannot be sustained. It will be well, in drawing up charges and specifications, to see that the following rules are strictly followed: The specifications should allege only that which is culpable and which the prosecution is ready to prove; to avoid duplicity, each specification must allege a distinct offense, and allege it in a clear and definite manner; the specification must not be argumentative; if possible it should distinctly charge some specific violation of law or regulation; the specification must be clear, brief, and explicit, in order that the facts, circumstances, and intent may be set forth with certainty and precision, and especially must it be shown that the accused committed the offense; the accused must be described with the greatest accuracy, and to this end, his Christian and surname should be written in full, his rank or rating and his place of service should be distinctly stated; the time and place where the offense was committed must also be accurately set forth; but if the time or place are not absolutely known, then it is sufficiently definite to say "on or about" such a time, and "at or near" such a place, keeping in mind that only a reasonable time would be admitted as a limitation; the person against whom the offense is committed must be described with as much accuracy as the accused, but if the party is not known, then the

specification may very properly allege that the offense was committed against a "person unknown"; the intent which constitutes the offense must be set forth, and when the law has adopted certain expressions to show the intent, these technical expressions must be used; the acts alleged to have been committed must be stated with certainty; the specifications must be free from abbreviations, and no part should be in figures, but the entire matter must be written out; when written instruments form part of the offense they must be set out *verbatim;* when only the substance of a written instrument is alleged it is sufficiently definite to allege it with the introductory words "in substance as follows." Each charge should be numbered, unless there is but one, and if there be more than one specification to each charge, they should also be numbered. The charges and specifications should be signed by the officer ordering the court and should be followed by his full title, and the time and place of issuing the same.

We have now traced the distinctive peculiarities of general courts-martial, and I had hoped to be able to give you a skeleton form of procedure for such courts with such comments as were deemed necessary, but in the limited time allotted me it will be impossible to do so; but it is not of importance to discuss the question of procedure of such courts at this time, owing to the fact that the office of the Judge Advocate General has but recently issued an authoritative form of procedure, which as a reference book will, I think, give you all the information on this subject, especially as it is intended to cover every possible contingency which would arise in the course of the trial.

Evidence.

There is one other subject which is deserving of your very careful consideration, and which I shall be able to give but passing notice, and that is the question of evidence. You can readily see how important this matter is to officers who, as members of courts-martial, in their capacity of judges, must pass upon the *admissibility* of evidence and then as jurors weigh it. It is almost too much to ask of an officer to require him to digest the numerous and voluminous works on evidence, and yet he is often called upon to decide the most intricate points, which judges would find difficult of solution. It is a rare occurrence, however, to

find grave errors committed by courts in this respect, and the question is often asked how it is that laymen passing upon the rules of evidence make so few mistakes. The only answer which I can find is that the rules of evidence have as their foundation justice and common sense, so when the exact rule of evidence covering the point in question is not known, a safe course to follow would be to ask yourself, is it right that such evidence should be admitted, is it common sense that such evidence should be admitted, and if the answer be in the affirmative, the chances of error are a minimum. There are, however, a few important points to which I will ask your attention, and hope that what I say may lead you to desire a closer acquaintance with the subject which can only be gained by personal research.

Courts-martial are bound in general to observe the fundamental rules of law and principles of justice observed by the civil judicature, and are also upon trials to be governed by the rules of evidence of the common law as followed by the criminal courts of the country. But, however, as the essence of all military proceedings is summary and rigorous action, and, as before stated, courts-martial are not even courts in the full sense of the term, but simply bodies of military men ordered to investigate accusations, arrive at facts, and when just to recommend a punishment, they can scarcely be held bound to the same strict adherence to common law rules as are the true courts of the United States, and upon trials they may properly pursue a more liberal course in regard to the admission of testimony than do the civil courts. The purpose of a court-martial is to do justice, and if the effect of a technical rule is to exclude material facts and obstruct a full investigation, the rule may and should be departed from; but it must be remembered that the proper occasions for such departures will be exceptional and infrequent.

The question of evidence may be divided into four heads, I, proof in general; II, admissibility of evidence; III, oral testimony, and IV, written testimony.

I. PROOF IN GENERAL.

Under the head of proof in general is considered (1) what is to be proved; (2) how must it be proved; (3) what is to be presumed; and (4) what is to be judicially taken notice of.

(1). At the very outset let me remind you that in a military court as in a civil court the burden is on the prosecution to establish the guilt of the accused, and not upon him to establish his innocence. In thus establishing the guilt, it must be shown that the act charged was committed; that the accused committed it; and that he committed it with the requisite criminal intent.

(2). In a civil case the plaintiff need only make out a *prima facie* case, or offer evidence materially preponderating over that of the defendant in order to give him a verdict, but the burden of proof on the prosecution in a criminal case is much greater, owing to the presumption of innocence which always exists, and to this presumption is due the rule of criminal evidence that the guilt of the accused must be established beyond a *reasonable doubt.* As this question of reasonable doubt is one which arises in every case at military law, I will quote from Colonel Winthrop on this subject as follows: "By *reasonable doubt* is intended, not fanciful or ingenious doubt or conjecture, but substantial, honest, conscientious doubt, suggested by the material evidence in the case."

In the case of the United States vs. Newton (52 Fed. R., 390), the court held that "it is an honest, substantial misgiving, generated by insufficiency of proof. It is not a captious doubt, nor a doubt suggested by the ingenuity of counsel or jury and unwarranted by the testimony; nor is it a doubt born of a merciful inclination to permit the defendant to escape conviction, nor prompted by sympathy for him or those connected with him."

From these citations it will be seen that the meaning of the rule is that the proof must be such as to exclude not every possibility of innocence, but every fair and natural hypothesis except that of guilt. As stated in Greenleaf on Evidence, "What is required is not an absolute or mathematical but a 'moral certainty,'" and as laid down in Winthrop, "A court-martial which acquits because, upon the evidence the accused may *possibly* be innocent falls as far short of appreciating the proper *quantum* of proof required in a criminal trial as does a court which convicts because the accused is *probably* guilty."

(3). Under the head of "What is to be presumed," we find two classes of presumptions, those of law and those of fact. By presumptions of law are meant the general propositions established

by the law, which are accepted without evidence by the courts as being *prima facie* true. These are of two kinds, those which are conclusive and those which are disputable. By presumptions of fact are meant those inferences as to the existence of a fact derived from some other fact or facts—in other words, inferences deduced by the human reason.

(4). As to the matter of which the courts take judicial notice we find that there are many facts of a conspicuous general or public character which so authenticate themselves in law that the courts take judicial notice of their existence as matters of course and which are not required either to be charged or proved; thus a court-martial takes judicial notice of the Constitution, public statutes, proclamations, the power of the President and executive departments, matters of public history, the Navy Regulations, general and special orders and circulars of the Department.

II. ADMISSIBILITY OF EVIDENCE.

One of the most important subjects with which a member of a court has to deal is that of the question of admissibility of evidence, and I again urge upon you to give this matter the careful attention which it merits, as I can in this lecture give it but passing notice. The three principal rules as laid down by the authorities are (1) the evidence must be relevant, (2) the burden of proof is on the Government, (3) the best evidence must be produced of which the nature of the case is susceptible.

By being relevant is meant that the testimony must be apposite to the material averments of the specifications, and be such as to establish or tend to establish the commission of the offense alleged. It need not directly tend to sustain the charge, but if shown to be a link of the chain it is relevant and admissible.

Nothing need be said on the point that the burden of proof is on the Government, for I believe that this is thoroughly understood by all of you.

By the *best evidence* is meant not the greatest quantity of evidence, but the term applies particularly to the quality thereof. It means that the most authoritative and legally satisfactory evidence of which the case is capable is to be produced. In fine, whenever it appears that there is a higher and better grade of evidence than that which is introduced, the evidence is not admissible. A familiar example is the attempt to introduce oral

or parol evidence when written evidence exists and can be produced. There are, of course, exceptions to this rule, but unfortunately time will not permit my adverting to them; but I will refer to one exception which is familiar to all of you, and that is the introduction of parol evidence to prove the contents of a document which is lost or destroyed, or in the possession of the other side.

In connection with the requirement that the best evidence of which the nature of the case is susceptible must be produced, we must consider the subject of hearsay evidence, which, as described by Greenleaf, is "that form of evidence which does not derive its value solely from the consideration to be given to the witness himself, but rests also in part on the veracity and competency of some other person." This form of evidence is invariably inadmissible, but care must be taken in deciding that it is hearsay, for every statement made by a third person is not necessarily hearsay, but frequently original testimony and admissible. Thus, when the question at issue is whether certain words were actually spoken by a person other than the witness, a recital of the words by the witness is original testimony and admissible.

Another form of declaration of a third person which is admissible is that which forms part of what is legally known as the *res gestae*. By *res gestae* is meant the circumstances and occurrences attending and contemporaneous with the principal fact at issue, or so nearly contemporaneous with it as to constitute a part of the same general transaction, which explain and elucidate such fact by indicating its nature, motive, etc. No rule can be laid down which will be a guide as to what is and what is not a part of the *res gestae*. It is a matter which must be left to the wise discretion of the court. A declaration made even a few seconds after the occurrence of a fact has been held not to be part of the *res gestae*, whilst under other circumstances a declaration made a week or months after the fact has been held as part of the *res gestae*. Each and every case must stand on its own bottom, and, as before stated, must be left to the sound discretion of the court, which of course is guided by the circumstances attending the case.

Courts are frequently called upon to pass upon the question of the admissibility of confessions made by the accused, and as a rule it may be stated that a confession is inadmissible unless

it be clearly shown by the prosecution that it was *voluntarily* made and not induced or materially influenced by hope of release or other benefit, or fear of punishment or injury, inspired by one in authority. The court is allowed to take testimony to ascertain the absolute conditions under which a confession is made in order that it may decide as to its being a voluntary act on the part of the accused. Again, before a confession can be admitted in evidence the *corpus delicti* must be proved.

Another point which frequently arises is that which goes to the competency of a witness, and it may briefly be stated that whilst formerly many persons were deemed to be incapacitated to testify, the rules in this respect have been relaxed, and I know of no class of persons who are incapacitated to testify before a court-martial except idiots, insane persons, persons in state of intoxication, very young children, and wives of accused persons. What was formerly a question of competency is now a question of credibility, which will be later alluded to.

Formerly in criminal prosecutions the accused could not testify, but by the act approved March 16, 1878, it was provided that the "Accused shall at his own request, but not otherwise, be a competent witness, and his failure to make such request shall not create a presumption against him." Care must be exercised by courts that the accused does not take the stand for any purpose except at his own request, and the record must invariably show this fact; if it does not it is a fatal error. With reference to the fact that no presumption lies against the accused on account of his failure to testify, the Supreme Court held that it was not allowable to make "comment, especially hostile comment, upon such failure," to the jury. "The minds of the jurors," it was further held, "can only remain unaffected from this circumstance by excluding all reference to it" (Wilson vs. United States, 149 U. S., 60). In like manner it may be said that it is highly improper for the Judge Advocate to comment upon this fact in summing up the case for the prosecution.

III. ORAL TESTIMONY.

The question frequently arises as to whether courts-martial being unable to secure the oral testimony of witnesses can have depositions introduced, and in reply it must be stated that depositions are inadmissible, as the law requires that the witness be

sworn by the president of the court and give his testimony to the court. The Department has for the past four years at each session of Congress submitted to that body the draft of a bill authorizing courts-martial, under certain circumstances, to receive depositions, but thus far it has been unable to secure favorable action from that body on this subject.

A witness may be allowed to refresh his memory by reference to a memorandum so long as it was made by him at the time of the fact or transaction to which it refers, or so soon afterwards as to afford the presumption that the memory of the witness was fresh at the time of making it. If the paper is not one made by the witness, it must appear that after inspecting it he can speak of his own recollection, otherwise he cannot use it. The privilege of using a memorandum does not authorize the witness to read his evidence from notes previously made.

Witnesses must confine themselves to statements of facts to the best of their knowledge and belief; opinions are not admissible except in two cases, the one being when a certain matter of fact resting wholly on belief is directly at issue, as the question as to whether a writing is or is not in the handwriting of a certain person, and the other being the testimony of experts on questions of science, or other questions requiring for their solution a peculiar skill or knowledge of a specialty.

A rule of evidence which frequently arises is that a party is not permitted to impeach the credibility of his own witness, but this must not be construed to mean that he cannot introduce other testimony as to a particular fact which is directly contradictory to the testimony of such witness.

Another rule is that in the direct examination leading questions must not be asked except where a witness is shown to be hostile to the party calling him, or where a witness's memory is so defective that he cannot recollect or specify a certain material fact.

On cross-examination, however, leading questions are admissible.

The cross-examination of a witness must be confined to the matter brought out in the direct examination and must not be extended to collateral matter with a view to contradict the witness by other evidence and thus discrediting him. Of course the right of cross-examination as a test of the perception, obser-

vation, recollection, and veracity of the witness is one which should not be denied and, therefore, for this purpose great latitude should be allowed.

When the accused, at his own request, goes on the stand, the greatest latitude is allowed in the cross-examination, which need not be restricted to the matter brought out in the direct examination, and in fact should not be restricted in any way. Very few cases arise in which counsel for the accused do not raise objection to the cross-examination of the accused, and contend that it must be restricted in the same manner as any other witness, but this is not true, and courts would err in sustaining such objection. On this point the Supreme Court has held: "A greater latitude is undoubtedly allowable in the cross-examination of a party who places himself on the stand than in that of other witnesses."

An established principle of the common law which has been affirmed by our Constitution is that a witness, whether the accused or any other witness, must not be required to answer a question that would criminate him; the witness can, if he desires, waive this protection.

In weighing the evidence of the accused, when a *prima facie* case has clearly been made against him by the prosecution, it is safe to rule that entire credit should not be given to his statements except in so far as he is corroborated by unprejudiced witnesses or reliable written testimony.

The question of the *credibility* of the testimony given by a witness is a most important one, for upon it rests the decision of the court in its capacity of jurors as to the proof of the various allegations. A witness is entitled to full weight for his testimony unless it can be impeached by the other party. How successful the impeachment has been made is a question entirely within the sound judgment and discretion of the court. Even when the character for veracity of a witness has been shown to be bad, his testimony is not to be wholly disregarded, but is to be considered in connection with the rest of the testimony and such credit given it as it appears to be entitled to receive. Also, when a witness has been shown to have testified falsely to a certain particular, the maxim, *falsus in uno, falsus in omnibus*, need not be applied, nor all his testimony disregarded, but it should be weighed in connection with the other testimony, and especially

so when corroborated. The general manner and bearing of a witness is an important consideration in weighing his testimony.

The relative number of witnesses for the prosecution and defense is by no means decisive in general, as the relative weight of the evidence depends much less upon the number of the witnesses than upon the quality of their statements.

IV. WRITTEN TESTIMONY.

The question of public and private writings in evidence is a very extended one.

Public writings are generally divided into judicial records and other public documents. Judicial records are admissible under the seal of the court.

Other public documents consist of acts of the legislature and executive departments of the Government, such as the acts of Congress and congressional debates and proceedings, executive proclamations, orders, communications to Congress. The Revised Statutes of the United States and the Statutes-at-Large are *prima facie* evidence of the law contained therein. A statute of Congress not yet published is proved by copy under seal of the State Department. General orders of the Department carry on their face their authenticity, and are receivable in evidence.

By private writings are meant contracts, deeds and other personal written instruments and obligations. The papers tendered to be introduced must be shown to be genuine, and if a copy, to be a true copy, and the handwriting must be proved.

I have endeavored to give you a brief outline of some of the more important rules of evidence, and such as most often occur in the proceedings of courts-martial, but you can easily realize that in the limited time allotted only a very superficial treatment of the subject can be given, but I trust that I have sufficiently shown the many interesting features, to offer you an inducement to continue your study of this very important subject.

With this review of the subject of general courts-martial I pass to the other tribunal of justice in the Navy—the summary court-martial.

Summary Courts-Martial.

In our service summary courts-martial were first authorized by the act entitled "An act to provide a more efficient discipline

for the Navy," approved March 2, 1855, and the provisions of this act as reaffirmed in the act approved July 15, 1870, constitute the authority for the jurisdiction and powers of our present summary courts-martial.

The summary court-martial is a court of very limited jurisdiction, and is to be resorted to only in those cases where the officer ordering it believes that the offense committed is one which is deserving of greater punishment than he is by law authorized to inflict, and still not sufficiently grave to warrant the offender being tried before a general court.

The authority for the convening of summary courts-martial is found in Article 26 of the Articles for the Government of the Navy, which provides—

ARTICLE 26. Summary courts-martial may be ordered upon petty officers and persons of inferior ratings, by the commander of any vessel, or by the commandant of any navy yard, naval station, or marine barracks to which they belong, for the trial of offenses which such officer may deem deserving of greater punishment than such commander or commandant is authorized to inflict, but not sufficient to require a trial by a general court-martial.

This, as in general courts, plainly defines what officers are authorized to order such a court.

The composition of such courts is controlled by Article 27, which provides—

ARTICLE 27. A summary court-martial shall consist of three officers not below the rank of ensign, as members, and a recorder. The commander of a ship may order any officer under his command to act as such recorder.

The procedure to be followed by summary courts-martial is in many respects similar to that of general courts, and as it is also set forth in the publication before referred to, I will simply ask your attention thereto, without in any way attempting to discuss it. It must be borne in mind that so far as the suggestions for drawing up specifications and the rules of evidence are concerned they are just as applicable to summary courts as to general courts.

As has just been indicated, summary courts are courts of limited jurisdiction, and in awarding a sentence they are restricted to the punishments as set forth in Article 30 of the Articles for the Government of the Navy, and here it may be well to state

that one of the most frequent errors made by summary courts in awarding sentence is to combine parts of the seven punishments which they are permitted to inflict into one sentence. The decisions on this point, which are numerous, are to the effect that any one of the seven punishments may be given, but when given it must be given in its *entirety*, to which, however, may be added extra police duties and loss of pay as authorized in the eighth clause of the Article. As a familiar illustration, the second clause of Article 30 provides for a punishment of "solitary confinement, not exceeding thirty days, in irons, single or double, on bread and water, or on diminished rations." Courts frequently award the solitary confinement on bread and water, but do not include in the sentence "*in irons*," single or double, which is a part thereof, and as a consequence such sentences are, whenever practicable, disapproved by the Department.

The action upon the record of the officer who ordered the court is so clearly defined in Articles 32 and 33 of the Articles for the Government of the Navy that a reference thereto seems to be all that is necessary.

As stated in Article 34 of the Articles for the Government of the Navy, the proceedings of summary courts-martial are to be conducted with such conciseness and precision as is consistent with the ends of justice. They are intended to be, as their name indicates, a summary method of administering justice.

Courts of Inquiry.

We will now briefly review the Courts of Inquiry as they exist in our service.

The act entitled "An act for the better government of the Navy," approved April 23, 1800, provided that "courts of inquiry may be ordered by the President of the United States, the Secretary of the Navy, or the commander of a fleet or squadron, provided that such court shall not consist of more than three members, who shall be commissioned officers, and a judge advocate or person to do duty as such, and such courts shall have power to summon witnesses, administer oaths, and punish contempt in the same manner as courts-martial." The act further provides that "such courts shall merely state facts, and not give their opinion unless expressly required to do so in the order for convening, and the party whose conduct shall be the subject of

inquiry shall have permission to cross-examine witnesses." The provisions of this act were subsequently reaffirmed by the act approved July 17, 1862, which is the source of the jurisdiction of our courts of inquiry at the present time. The wording of the act is so clear that no comment thereon is necessary, as the source of jurisdiction, the composition and powers of such tribunals are concisely stated.

Courts of inquiry are resorted to in important cases, when the facts are various and complicated, when there appears to be ground for suspecting criminality, or when crime has been committed, or much blame incurred without any certainty on whom it ought chiefly to fall, in order to collect, sift and methodize information for the purpose of enabling the convening authority to decide upon the necessity and expediency of further judicial proceedings. It might be well to state here that the object of a court of inquiry is simply to give information to the officer ordering it, and is in no wise considered as a decision on the subject which is binding, and in its scope is not restricted by statute of limitation to any time subsequent to that at which the matter to be inquired into occurred. In fine: a court of inquiry is simply the medium through which the officer ordering it expects to get at the absolute facts in the case in order that he may determine whether or not further action may be necessary.

The composition of the court, either in regard to the rank of its members or the department of the service to which they belong, should be regulated by the circumstances to be inquired into. If the conduct or character of an officer is to be inquired into, the members of the court should not be, if possible, inferior in rank to that officer. If the officer be one of the staff corps, or the marine corps, it is proper, if the exigencies of the service will permit, that one or more officers of his corps should be detailed on the court.

As to the question of procedure of courts of inquiry I again invite your attention to the forms of procedure before mentioned, which fully cover all the different kinds of courts of the character that can be organized. It may be well to state, however, that in one material respect this form of court differs from general and summary courts-martial, and that is that while the Judge Advocate of a general court-martial and the recorder of a summary court-martial are required to withdraw when the

court is closed, the Judge Advocate of a court of inquiry is permitted to be present at all times and does not withdraw.

It may be well to state that the court should always keep in view the fact that the purpose for which it is organized is the examination of witnesses under oath in order that the absolute facts of a case may be determined for the information of the convening authority, and that the proceedings should be orderly and conform with those of other judicial bodies.

As was stated above, a court of inquiry is simply convened to gather information for the convening authority, and it is entirely within the discretion of such convening authority to be guided or not by the finding and recommendation of the court, so that although a court should recommend that no further action be taken, the convening authority can nevertheless, if he deem it proper, take further action and *vice versa*.

Article 60 of the Articles for the Government of the Navy provides that—

> The record of proceedings of a court of inquiry shall, in all cases not capital, nor extending to the dismissal of a commissioned or warrant officer, be evidence before a court-martial, provided oral testimony cannot be adduced.

Numerous cases have arisen in which the Judge Advocate of a general court-martial endeavored to introduce the record of a court of inquiry as evidence before a court-martial, and the court being apparently unable to decide how far the above provision of law is applicable, the Department finally, in General Court-Martial Order No. 88, dated October 21, 1895, laid down for the guidance of courts its decision in the premises, and to this order I invite your careful attention. It is in effect that unless the charge be laid under an article for the government of the Navy which in case of conviction makes it mandatory upon the court to give a sentence of death or dismissal, the record of a court of inquiry is admissible in evidence provided it be shown that parol evidence can not be introduced. For the purpose of impeaching a witness it is always admissible, provided that a proper predicate be laid.

An officer whose conduct is to be investigated by a court of inquiry need not be put under suspension or arrest for that purpose, but it is proper for his superior officer to excuse him from his ordinary duties during the investigation.

The "party accused" is entitled to be present (with counsel if desired) so as to take part in the examination of witnesses and to introduce evidence, but his presence is not at any stage obligatory or essential. He is sometimes, though rarely, ordered to be present, and in that case he must attend, although his absence may not affect the authority of the court to proceed. He may, at his own request, take the stand as a witness, but he cannot be compelled to do so.

The reviewing authority, upon the receipt of the record of proceedings, may, if he deem it proper, return it to the court for revision, and, unlike a court-martial, new evidence may be received and recorded on every occasion; and the court may recall and re-examine any of the previous witnesses with a view to eliciting all possible information which the case admits.

We have now briefly reviewed the law by which the Navy, as a separate community, is governed, and also the various tribunals by which it is administered, and whilst I feel that it has been of an extremely superficial character, yet I trust that sufficient has been shown to arouse in you a desire for further research, and if I have succeeded to this extent I shall feel that my work has not been in vain. I will, therefore, in conclusion, recommend to your earnest consideration, from amongst the numerous authorities, as books of reference, Winthrop's Military Law and Precedents; Greenleaf on Evidence; and the Forms of Procedure, issued by the Office of the Judge Advocate General of the Navy, as these will furnish substantially all the information which is necessary to the student of military law.

My thanks are due to Colonel W. Winthrop, U. S. Army, from whose valuable work "Military Law and Precedents," much of the information upon which these lectures are based was taken.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

IMPROVEMENTS IN ORDNANCE AND ARMOR IN THE RECENT PAST AND FUTURE.*

By P. R. ALGER, Professor of Mathematics, U. S. Navy.

To-day I ask your attention to a discussion of the question of the accuracy of gun fire and the steps which have been and yet remain to be taken to increase it.

Strange as it may appear, it is in this direction that the greatest progress has recently been made, and it is in this direction that the greatest possibilities of improvement still lie. The use of a practicable telescope sight on naval guns, and the introduction of efficient methods of controlling their fire in action, will, in my opinion, so greatly increase their efficiency as to dwarf the importance of the other ordnance developments of recent years.

It has long been recognized by those who have investigated the subject, that it is physically impossible for the human eye to judge when three points at widely different distances are in one straight line, yet this is the thing which must be done every time a gun is sighted by the usual means; and upon the accuracy of the judgment depends almost entirely the accuracy of the fire of the gun. The errors of the gun itself are as nothing in comparison with the errors of pointing, due to mistaken judgments of distance, speed and wind force; but even these errors sink into insignificance when compared with the errors caused by firing the gun when the line of sight does not pass through the target.

Practice makes perfect is almost universally true, but it is a well-known fact that the good shot is usually born so and not

* Lecture delivered before the Naval War College, Newport, R. I.

made so. The majority of men never can be taught to shoot well, and no man can shoot so well with the ordinary sights as to make the errors of modern guns of any importance whatever. With the telescope sight this is all changed. Every man, whether his eyes be good or bad, if he can see at all, sees, when he looks through the telescope at the target, two things: one, the image of the target, the other, the cross-wires in the telescope; and the image and the wires are in the same plane, so that as the movements of ship, gun and target change their relative positions, no man can possibly fail to distinguish and know when the cross-wires cover the image of the target; and if at that moment the gun be fired, then, barring the errors of the gun and the errors of estimation of distance, speed and wind force, the shot must strike the target. In other words, that error in firing guns which is so great as to mask all others, namely, the personal error of the gun pointer, is eliminated by the use of the telescope sight.

As a rough estimate, I should say the mean error of one of our large guns, measured on a vertical plane, is about one yard at a range of 2000 yards; or if gun and target are stationary, sights set for correct range, and line of sight pointed exactly at the center of the target, no shot will strike more than about three yards above or below, to the left or right of the center; and the mean of the vertical errors, as well as the mean of the horizontal errors, if a number of shots are fired, will be about one yard. These errors evidently are so small as to be negligible. In actual service we have additional errors due to lack of precise knowledge of distance, of relative motion of gun and target, and of force of wind. At 2000 yards range the deviation due to a stiff breeze at right angles to the line of fire will not be more than four or five yards. At the same range, and supposing gun and target to be passing each other at the rate of 30 knots, the deviation of the point of fall due to this motion will be 50 yards. In other words, with no attempt at correction, the lateral error in an extreme case may be 55 yards. It hardly seems too much to expect any person, after reasonable experience, to estimate the total lateral correction within 50 per cent., which would make 27½ yards an *extreme error*.

The speed at which his own vessel is to be fought should be known to each gun pointer, as well as how much, and in what

way, he is to allow for it, and this, taken together with the roughest guess at a correction for the enemy's speed, and with no allowance for wind, should reduce the *mean* lateral error caused by imperfect knowledge of speed and wind corrections to certainly not more than 10 yards. A scale graduated for speed in knots affords a fairly accurate means of correcting for relative movements of gun and target, especially as this makes the correction practically independent of distance. However, with careful instruction and practice, the gun pointer should learn to make the correction within the limits above by pointing to one side or the other of the center of the target. In doing this no attempt at calculation need be made, and the effect of wind may be entirely disregarded. The gun pointer need only know the deviation at 2000 yards resulting from the speed of his own ship when the line of fire is abeam, and by following the rule of aiming at the middle of the enemy when both ships are moving in the same general direction, and ahead of the middle of the enemy by the amount of that deviation when both ships are moving in opposite directions, he will come near to making the proper lateral correction. For example, the correction for beam fire from a 15-knot ship is 25 yards at 2000 yards range. Then, on such a ship, let the gun pointers be simply taught to always fire at the middle of an opposing ship when she is steaming in the same general direction as they are, and to fire at a point ahead of the middle of the opposing ship when she is steaming in an opposite direction to their own, the distance ahead of the middle to be 25 yards at 2000 yards range, 12 yards at 1000 yards range, and 37 yards at 3000 yards, and even such a crude method of correcting as this will reduce the mean lateral error due to relative movements of gun and target and to wind force within the limit before stated, 10 yards. As for the vertical error, due to setting the sight bar for the wrong distance, the mean value of this, of course, depends entirely upon how closely distance can be determined and communicated to the gun pointer. Theoretically, it would appear well to use a range finder and range indicators, by means of which, as long as everything was in working condition, the sights could be set with an error of about two per cent. of the distance, which, at 2000 yards, would *only* cause the comparatively insignificant vertical error of less than one yard with our larger guns.

If we reject instrumental aid altogether, and make no effort to correct the range by observing the fall of the shot, then, since the mean error of the best judges of distance is said to be about 15 per cent., we should have, under the same conditions, a mean vertical error of some seven yards, which is, of course, a very serious one. But suppose that we have means of determining distance within 5 per cent.—and undoubtedly a practised observer watching the points of fall of the shot fired by well-trained guns' crews can judge distances within 5 per cent.—then the mean vertical error from this cause will be only about two yards.

Thus we see that with very simple and crude methods of estimating range and correcting for speed and wind, the mean vertical error should not exceed 7½ feet, nor the mean lateral error 30 feet, at 2000 yards range, *provided only* that the gun is fired when its line of sight passes through the target. In other words, at 2000 yards range the percentage of hits on a target 15 feet high and 60 feet long, if its center be pointed at, should be 50, and every shot should strike a target 45 feet high and 180 feet long.

But we all know that such a percentage of hits is never actually attained in practice, and in the excitement of action, judging from past experience, we would hardly expect 10 per cent. of hits at 2000 yards range. Admiral Ito is quoted as saying that the percentage of hits at the battle of the Yalu was about 10 per cent. for the Chinese and 15 per cent. for the Japanese guns, but the fact that out of 197 12-inch projectiles fired from the two Chinese ironclads, only seven struck Japanese vessels, hardly supports this estimate. In that action the firing was so wild that among its earliest results was the destruction of the men in an armored top by the bursting of a large shell and the cutting away of almost all the halliards on the Chinese ships. It is not to be supposed that a large gun was intentionally aimed at the enemy's top, and, in fact, the action was fought almost entirely at such long range as to make this supposition absurd. Most of the damage done aloft was by ricocheting shell and fragments of shell which had burst on impact with the water, and not by the direct hits of projectiles.

Now, what I contend is, that such bad shooting has been principally caused by using sighting arrangements so imperfect as to make it impossible for any man, however careful and cool, to

determine exactly when his line of sight is on, while with the telescope sight no man can help knowing when the line of sight is on. Of course great skill is required to so handle the gun as to bring its line of sight on, and excitement and impatience will frequently cause men to fire without waiting till the proper moment, but the fact remains that with the telescope sight for the first time it is possible to know the proper moment for firing. The skill which is now needed is that which can be acquired by exercise and drill in pointing guns at moving objects, and in no other way. Let a man be given sufficient practice with a gun, so that he is able to rapidly bring the line of sight upon a moving target; give that man the range within 5 per cent., and he has then only to have sufficient coolness and self-restraint not to fire except when the line of sight is on and he will hit a battle-ship at 2000 yards with almost every shot. Of course it is no easy thing to point a heavy turret gun accurately; a turret weighing 500 tons cannot be stopped and started instantaneously; but with practice sufficient skill can be acquired, and in no other way. To take advantage of the relative motions of gun and target by stopping the turret with the line of sight ahead of the target and firing as it comes on, or to train slowly in the same direction as the target is moving and fire as the line of sight comes up and slowly passes across the target, these are things which no man can do well in time of excitement unless he has done them thousands of times before in exercise. But any intelligent man can do them well if he has had sufficient practice, and if he does them well, he can, with the telescope sight, do such shooting as has never before been done with a gun at sea.

Another bar to accurate shooting at sea which has been partially overcome is the necessity of allowing for the time interval between the moment of willing to fire the gun and the actual discharge of the projectile from its muzzle. It has been, and I suppose still is, the custom of men who fire guns at sea to pull the lock-string just before the line of sight comes on, thus introducing a considerable personal error. This should no longer be done now that electric firing has been brought into use. With the electric firing key in his hand, the gun pointer has only to press the button, or otherwise close the circuit, when the cross-wires are at the center of the image of the target, and he

need have no fear that the roll of the ship will deflect his aim to a serious extent.

With percussion firing mechanism, the time which elapses between the first movement of the hand on the lock-string and the fall of the striker may vary from .02 to .11 of a second according to the expertness of the man and the efficiency of the firing arrangements, and the probable mean value of this interval leads us to conclude that with a ship rolling very moderately, a vertical error of 4 or 5 yards may easily result from this cause. Moreover, the attempt to correct for this by pulling just before the line of sight comes on is likely to introduce even larger errors, and, what is also important, irregular ones. Of course no system of firing can overcome the error due to the time it takes the projectile to traverse the bore, but this is only about one-third of the total error, and the other two-thirds, due to the time it takes to fire, practically disappear with electric firing. It may be said that the errors referred to would not exist if the well-known rule of firing at the end of the roll were followed, but such a rule cannot be followed strictly. If the gun be so laid that the sights come on at the end of one roll, perhaps the next two or three rolls do not bring them on at all, and so the rate of fire is greatly diminished. Men should be instructed, therefore, to follow the rule only to the extent of pointing so that the sights come on *near* the end of the roll, never at its middle, when the speed of roll is greatest. And here again we see the great value of practice in pointing guns under service conditions; the man who has sufficient skill—and this can only be gained by experience—to so point his gun that the line of sight comes on near the end of the ship's roll, thereby eliminates a source of error so important that it has been deemed wise to introduce the system of electric firing solely to reduce this error. Moreover, the longer the gun, the greater the error to be overcome is.

It must not be supposed, however, that all these great advantages can be attained at once and without accompanying disadvantages and sometimes mistakes. In the first place, it was very difficult to obtain a telescope of large field and yet otherwise satisfactory, and those first issued had a field of only 4°, which is entirely inadequate. With such telescopes, the ordinary rolling and pitching throw the target completely out of the

field of view, as does also a small relative lateral motion, and this makes it extremely difficult to get the image of the target at the cross-wires. The telescopes now being issued, however, have a field of 17°, which makes pointing easy, since the target remains in the field of view except when the rolling is very heavy.

Then again, much complaint is heard as to the unreliability of electric firing under service conditions. Electric batteries run down, circuits are broken, wires short circuit, primers fail, and things generally fail to work on some ships, and then the system is condemned. The fact is that electric firing does necessitate much more complex attachments than firing with percussion or friction primers, and it does take correspondingly more care and attention to make such a system work well; but it can be done, and it is well worth working for. Our original electric firing attachments were deficient in strength and were too complicated; moreover, the mistake was made of not issuing enough spare electric cells; also some of the earlier lots of electric primers were defective. Even with these, however, from some ships perfectly successful and efficient results have been reported at every target practice, showing what can be accomplished even with poor material by taking pains.

Now we have electric primers which can be counted upon never to fail; we have improved the attachments, and we issue a large number of spare cells to each ship. Consequently, with a reasonable amount of attention, electric firing should prove to be just as reliable as percussion firing has long been.

Another point of advantage with the telescope sight is that it will be far more efficient at night than an ordinary sight.

But after our ordnance material has been perfected to the highest practicable point, after our individual gun pointers have attained the highest possible proficiency in target practice, there is still a vast and, unhappily, almost unexplored field for development in the practical working out and perfecting of a system for controlling and regulating the fire of the battery as a *whole*. What the best way of doing this is depends, of course, very largely upon the design of each particular ship, and it is unfortunate that in making these designs in the past but little attention was paid to the important matter of so arranging their batteries as to make control possible. If each gun is in a com-

partment by itself, and widely separated from the other guns, it is still possible to install a system of communication, electric or other, whereby the range and other needful directions may be sent from a central station to each gun. But such a system would almost certainly break down early in an action; the wires or tubes running from end to end of the ship and through numerous bulkheads would soon be cut or injured, and all communication, except by messenger, would be cut off. It cannot be supposed that range can be accurately judged or points of fall of projectiles observed from a closed turret or through a small port on a covered deck. Cut off from knowledge of the distance of the enemy, ignorant of whether their shot are falling short or over, and with no one to regulate the rate of their fire, the best trained men are likely to throw away their ammunition. What we need is some simple system, independent as far as possible of tubes and wires, whereby an officer, trained in the art by frequent practice, shall be able from a commanding position to direct and control the fire of the whole battery. Having devised such a system, all drill and all target practice should be conducted with a view to perfecting officers and men in its use.

It seems to me that the commanding officer of a ship in action has enough to do in handling his ship, manœuvring as directed by signal, or independently, as the case may be. To keep the enemy constantly on a bearing which will allow the most efficient use of the greatest possible number of his guns is a sufficient problem to keep a commanding officer occupied in a single action, as it would also be in a fleet action to follow the directions of the commander-in-chief; while in either case he must be prepared to use his torpedoes, to attempt to ram, to manœuvre to avoid ram or torpedoes, and generally to meet any emergency which may arise. I should therefore advise that on each ship an officer be appointed to the important duty of directing the gun fire. This officer, with one or more assistants, must have a station from which he can observe the fall of shot, measure or estimate range, and communicate directions to the guns, and no other place seems to me to compare in advantage for this purpose with a lofty top. I would, if necessary, give up entirely to this purpose one or both of the tops in which we now carry machine or R. F. guns. It would seem possible to

so place a mast or masts on board any ship as to give one top which will always be clear of smoke from the funnels, and so high as to be fairly safe from injury by the enemy's fire. From this top, or from each of them if there be two, should lead such permanent tubes and wires as will give the communication best suited to the particular ship. Range indicators like the Fiske, having their faces graduated for ranges and also for certain specified directions controlling the fire, will probably be the best method of communication, but there should always be means of rapidly replacing cut wires, or, perhaps better, a second system of wires could be kept ready and put in place as a regular thing in clearing ship for action. If nothing better can be gotten, a system of signals by bugle or drum could easily be made to work well on many ships. On turret ships there would of course be an indicator in each turret with permanent wires, and the second circuit could be by wires direct from the top through the turret roofs. As a means of measuring range, the sextant for a first observation, and the stadimeter, after the height of the enemy's mast or stack has once been determined, should be fairly efficient. Or any of the single station range finders, like the Barr and Stroud, will do. The disadvantage of the Fiske range finder is its requirement of two stations with a wide distance apart. As installed at present, it seems certain that these range finders would be put out of action almost at once, and if two tops are available, placing the observing stations in them would certainly increase the likelihood of their escaping injury. Of course in a single action one accurately measured distance transferred to the stadimeter is sufficient, and therefore the range finder may be dispensed with, but in a fleet action this would not be the case, as the different phases of the combat would bring different adversaries to each vessel. Even with no instruments, however, good work can be done with experience, provided the guns' crews have been trained to the system. I spoke a moment ago of the irregularity of the errors caused by attempts to allow for the firing interval as being a special disadvantage, and what I meant was that for good battery practice it is above all important that all the gun pointers shall shoot alike. In other words, their training should be directed to the end of making them shoot uniformly. If you can count upon every gun pointer in the ship dropping his shot at about the

same place with the same sight bar setting, then it makes not an iota of difference whether he shoots 500 yards over or 500 yards short, provided the sight bar settings can be regulated by a person who sees where the shot are falling. With the ordinary sights it was actually impossible to attain this desirable end or even to approach near to it, although constant aiming drill would always result in great improvement. But with the telescope sight and electric firing the desired end is possible, and it only remains to teach the men two things and we come near to perfection. The first thing is easy enough—it is merely that the sight is always to be set as directed by the officer controlling the fire of the battery, and is never to be changed because the individual gun pointer or divisional officer thinks his shot are going over or short. In other words, in order to direct the fire with any approach to efficiency, the controlling officer must be able to count upon all sights being set as he directs and only changed as he directs. The second thing, however, is not easy, and, in fact, never can be taught or acquired completely—it is not to fire except when the line of sight is on the target. With the telescope we can tell when this is the case, which we could not do formerly, but with any and all forms of sight we have to contend with the excitement and impatience of the gun pointer. Perhaps the motion renders it difficult to get the line of sight on, or smoke obscures the view and only allows an occasional glimpse of the enemy, and in the excitement of action the gun captain cannot wait patiently, as he may be trained to do in target practice, but takes his chance, fires blindly and loads again. I say this cannot be entirely prevented, but still practice and instruction in peace time can at least reduce it to a minimum, and even in the heat of action the warning notice from aloft that they are shooting wildly will have its effect on well-trained men.

These three requisites, then, are essential for efficient work on the part of a gun pointer: 1st. He must set his sight as he is told. 2nd. He must be able to quickly bring his line of sight on to the target. 3rd. He must not fire until his line of sight is on the target. The 1st and 3rd of these requisites can only be attained as the effect of discipline and training on selected men, and the main object of all the routine of exercise drill and daily life on board ship should be to instill into the men those habits

of obedience and readiness which will cause them to do what they are told to do even in the most trying moments. The third requirement—that of ability to quickly bring the line of sight on the target at sea—is wholly a matter of actual practice with the guns themselves, and lack of this ability on the part of the gun pointers on any ship should be considered a reproach to the commanding officer of that ship.

But there is one other thing which the gun pointer must be taught, and that is what part of an opposing ship to aim at. It appears to be quite a generally held opinion in our service that the point to aim at should be different for different guns, or, in other words, that gun fire should be "discriminating," the heavy guns being directed against the armored portions of an adversary and the lighter guns against his unarmored parts. Not only in the contributions of naval officers to our own publications, but in professional articles in foreign papers, it is of frequent occurrence to read such statements as the following: "The opening range being too great to admit of piercing the heavy armor of a battle-ship, shell should be used and the unarmored or lightly armored portions of the enemy should be the target," and "He (the commanding officer) should designate the various parts of the enemy's vessel as targets for each caliber and see that the officers understand how to change the point aimed at according to the construction of the enemy's vessel." Moreover, in the opinions of a number of officers for and against the superimposed turrets of the Kearsarge and Kentucky, the principal objection urged was the impossibility of simultaneously pointing the 8-inch and 13-inch guns against different parts of the enemy. Now in my opinion discriminating fire from naval guns under service conditions is usually both impracticable and injudicious. I believe that the best results will be obtained, at least with the larger guns, by always aiming at the middle of the target, except in so far as an attempt is made to correct for wind and speed, and this for two reasons.

First, a consideration of the apparent size of a ship at such a distance as is likely to be used in naval engagements shows the impracticability of nicely selecting particular portions of her structure as the point of attack. The Indiana, for example, when broadside on at 2000 yards range, looks to be of the same size as a picture of her, eight-tenths of an inch long, held at the

point of clear vision, some 14 inches from the eye, while the outlines of the real ship will be much less clear and distinct than those of the picture. About one-half of the length of the Indiana at the two ends, having a freeboard of 11 feet, would show in the picture as about one-fortieth of an inch high, while the highest portions, excepting stacks and mast, would appear but about one-fifteenth of an inch high. Now when it is remembered that the line of sight is moving rapidly up and down as the ship rolls, and at the same time to the right or left as the ship and her opponent pass each other, so that it is constantly describing a more or less sinuous curve, at one instant pointing far above the target and at the next far below it, the difficulty of selecting the point to aim at with any nicety will be at once recognized. Assuming, for example, the very moderate roll of 4° each way from the vertical, a rolling period of eight seconds, and a relative motion of ship and target of only 10 knots per hour. Then, taking the Indiana at 2000 yards as the target, the line of sight every eight seconds will range over about 850 feet vertically and 130 feet sideways, and as it passes across the target, will occupy only about one-tenth of a second if it crosses near the ends. The most skillful man cannot hope to keep his line of sight constantly trained on a particular part of the length of the enemy, consequently as the roll causes the line of sight to pass up and down across the target, each time it will be at a different part of her length, and if the point aimed at be near one end, the greatest skill will not prevent the line of sight from frequently not crossing the target at all. Thus even if finally the gun is fired as it points at the selected part, much time must be lost in vain attempts to attain this end.

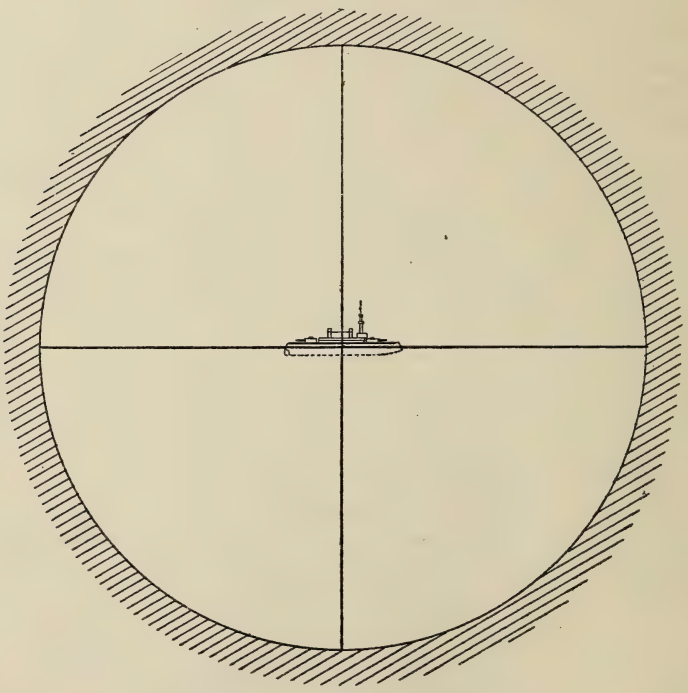
In the second place, even were it entirely practicable to use discriminating fire, as perhaps is the case when the range is 1000 yards or less, I think it can be shown to be generally injudicious. Not only would the rate of fire be diminished by the difficulty of pointing at a selected part, but unless that part were near the center of the target the percentage of hits would be materially reduced.

It may very well be that when firing at such a vessel as the Kearsarge, whose whole middle length is armored, it will be best to direct the small rapid-fire guns against the middle of the unarmored portions at bow and stern, since though the per-

centage of hits would undoubtedly be reduced, the percentage of effective hits might not be. With the larger rapid-fire guns, however, and, above all, with the armor-piercing guns, the middle body of the enemy's ship should always be aimed at, since the chance of hitting at all is then the greatest, and the natural errors of firing will distribute the hits just as effectually as would any attempt to do so by aiming special guns at special parts. Not only is the chance of doing damage with a heavy shell, wherever it may strike, too great to render it advisable to adopt a system which will reduce the number of hits, but the system referred to may often actually reduce the chance of hitting the parts specially selected for attack. Take, for example, the 13-inch turrets of the Indiana, each some 30 feet in diameter and 130 feet apart. A 13-inch gun aimed at the middle point between the two turrets would, in the hands of the average gun pointer, actually have a greater chance of hitting one than if it were aimed directly at either turret. How unwise, therefore, would it be to direct the heavy guns of a battle-ship specially against the turrets of an opponent. Until our practice is much better than at present, let them always be aimed at her middle length, with such allowance for speed as is thought proper, and not only will they make more hits on the enemy as a whole, but they will even make more hits on the enemy's turrets.

As for the question of the proper height at which to aim, this depends altogether upon the probability of hitting after ricochet. With the old smooth-bore guns it was undoubtedly best to aim at or even slightly below the water-line, because spherical shot ricochet with great regularity when the sea is comparatively smooth, and consequently a shot falling short had a good chance of hitting on the rebound, while one going over was wasted. With rifled guns, regularity of the ricochet can no longer be counted on; not only does the projectile deviate sharply to one side upon impact with the water, but unless the water is perfectly smooth it is impossible to count with any degree of certainty upon either the direction or the angle at which it will rise from the point of impact. Under these circumstances it seems to me to be best to aim slightly above the water-line. If every shot which fell short was lost, undoubtedly the best point to aim at would be the center of the freeboard, but since those which fall very little short may hit after ricocheting, the best results would seem to come from aiming a little above the water-line.

The drawing which I have here is an exact reproduction of what the gun pointer would see if he directed a telescope sight of our present pattern upon the Indiana at 2000 yards range. By imagining the picture of the ship to be moving rapidly up and down, and somewhat less rapidly to one side in the field, you can form an idea of the difficulty which would attend the attempt to select a special part to fire at.



Reduced one-half actual size.

The foregoing being the rules to be followed by the gun pointer, all instruction and drills should be with a view to instill them into his mind and to give him the ability to carry them into effect, and to this end the actual firing of the guns is not at all necessary. With the telescope sight and electric firing, a man can become a most expert gun pointer without firing a shot, and all that can be taught to the men by firing the guns is not to be disturbed by the noise and shock of the discharge of their own and neighboring pieces. But target practice has

another and far more important use than this. Its true end should be not to teach the individual gun pointers to shoot, but to teach the commanding officer and his subordinates to handle the ship and her battery as a whole, so that in the supreme moment of actual conflict she shall be a unity of intelligent co-operating parts. There is little or nothing to be gained by putting out a target at known distance in smooth water, leisurely steaming to and fro past it, firing one gun or one division at a time, carefully plotting the fall of the shot and awarding prizes to the men who make the best records. No, let the ship be cleared for action and handled as she would be in action. Let the methods of communication and of determining range which can best be used in action be learned; let the battery be used as a whole; let the ship be at the speed she would have in action, and let her be manœuvred as she would have to be in action. The reports of target practice frequently bear the remark, "Smoke interfered greatly with the firing." Let us learn how to manœuvre a ship so that the smoke will not interfere greatly, otherwise we may be seriously handicapped when we come to real fighting. I suppose that it may safely be said that hardly a ship in our service has ever had her whole battery in use at one time, and that hardly one commanding officer in our service has ever taken his battle station and handled his ship as he would have to in action. It seems to me that every target practice should be as exact a copy of an actual fight as possible, and that plotting the shot for the purpose of publishing the records of individual gun pointers is utterly unimportant in comparison with determining the best way to use the battery as a whole and teaching officers and men how to do it.

I appreciate the value of target firing to the gun pointers as affording a check upon their accuracy, and as lending interest to the otherwise tiresome business of working the guns. If a man has never had a chance to fire at a target at leisure, neither he nor his instructor will ever know whether he can actually do good shooting. But subcaliber practice has all the advantages of our present regular target practice, with the added one of being constantly possible and of little expense. The firing of the battery itself should be mainly a lesson in warfare, and only incidentally a lesson in shooting. Moreover, we devote too much time to unimportant accessories, teaching the men to perform

the manual of arms, march in company, handle a revolver or single-stick, and fire at a stationary target in smooth water. If each ship had ten years in which to be prepared for war, it might be well enough to have a long course of preliminary training before entering on the final stage of rehearsing an actual combat, but we never get beyond the preliminary stage. Let us have what is useful and indispensable first, and *then* the accessories, and even refinements, if there is time. Preparation for war should be our sole thought, the final end of our efforts, the center about which all else should turn. Above all, let us learn the lesson that nothing has any value as a matter of drill or exercise which does not lead directly to the realization of that supreme result—success in war.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE CAPABILITIES OF THE CHART COMPASS.

By G. Herrle, U. S. Hydrographic Office.

The notable improvement in the construction of the chart compass inaugurated within the last ten years in the United States, and since then also in other countries, suggests the idea to extend the usefulness of this device by showing how certain problems in navigation and in nautical astronomy can be solved by means of it quite readily within the limits of accuracy usually attainable in the measurement of a rhumb course or bearing.

It may be argued that, as the elements in nautical astronomy are required more closely than a course or bearing, and as there is already in existence a multiplicity of devices, tabular and graphic, intended to save computation and give results more or less accurate, any additional device for a similar purpose would be superfluous. For certain purposes, however, rough results are often sufficient, and in such cases, when other means are not at hand, a knowledge of the solutions by the compass would be of value; and further, it may be said that not a new device is involved, but simply new methods applied to an old device universally employed by mariners.

And possibly a knowledge of the fact that a number of problems can be worked out on the compass may, in the future, when these methods have become more generally known, lead to the adoption of at least one larger compass on coast charts, and may induce efforts to still further improve the construction of the compass by making the graduation of the ream more accurate than it now usually is.

The solutions given in this paper are based on the graphical translation of the well-known equation of the spherical triangle,

$$\cos c = \cos a . \cos b + \sin a . \sin b . \cos C, \qquad (1)$$

which, by the substitution of equivalents, may be made to read:

$$\cos c = \frac{\cos (a-b) + \cos (a+b)}{2} + \left[\frac{\cos (a-b) - \cos (a+b)}{2}\right] . \cos C \quad (2)$$

In these equations a and b denote two of the sides, C the angle included between them, and c the third side of the spherical triangle. The translation will first be explained in detail, and later on rules deduced for the solution of the astronomical triangle.

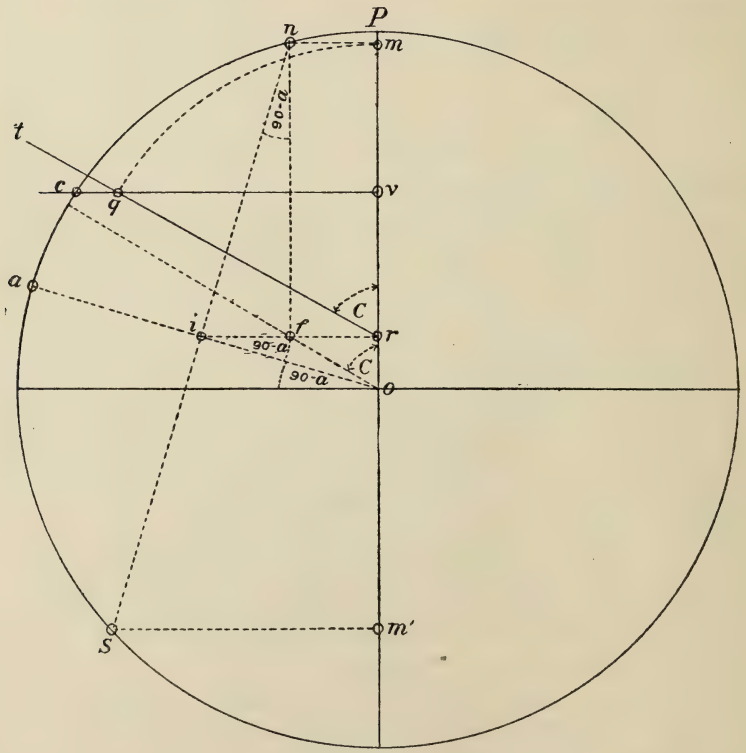

FIG. 1.

If on a circle (Fig. 1) the arc Pa is made equal to the side a of a given spherical triangle, and the side b is laid off from a to the northward and southward to the points n and s respectively, then nm and sm' drawn at right angles to the north and south line of the circle, and mm' divided into two equal parts at r, then:

$$om = \cos(a-b), \quad om' = -\cos(a+b),$$

$$\frac{om+om'}{2} = \frac{mm'}{2} = rm = rm' = \frac{\cos(a-b)-\cos(a+b)}{2}, \tag{3}$$

and

$$\frac{om-om'}{2} = ro = \frac{\cos(a-b)+\cos(a+b)}{2}, \tag{4}$$

which are the terms occurring in equation (2).

Or we may obtain the corresponding terms in equation (1) directly from the triangle *inf*, in which

$$in = \sin b, \quad \text{and angle } inf = 90° - a,$$

hence

$$nf = rm = \sin a \,.\, \sin b, \tag{5}$$

and from the triangle *oir*, in which

$$io = \cos b, \quad \text{and angle } ior = a,$$

hence

$$ro = \cos a \,.\, \cos b. \tag{6}$$

If we now lay off from r the line rt, making the angle C with rm, and with rm as a radius intersect rt at q, and through q draw a line at right angles to rm, then

$$vr = rm \,.\, \cos C,$$

and

$$ov = ro + vr = \cos a \,.\, \cos b + \sin a \,.\, \sin b \,.\, \cos C,$$

and as ov is the cosine of the arc Pc, that arc is equal to the length of the third side c of the triangle.

Or, if the angle C were to be found, a, b and c being given, we first find r and radius rm, then lay off from P the arc $Pc = c$, draw the horizontal cv, and with rm as a radius intersect cv at q, and measure the angle C included between the lines rm and rq.

The main operation then in the whole process consists in finding the position of the point r above or below the center of the circle, and the length of the radius rm; and as point r lies in the horizontal drawn through the point of intersection i of radius oa and of the line connecting points n and s, the elements ro and rm are always easily and quickly obtained. It will further be seen that ro and rm retain precisely the same values whether we first lay off from P arc a and then add arc b northward and southward, or whether we first lay off arc b and then add arc a northward and southward.

We will now utilize the process explained, in the solution of the

astronomical triangle, designating its different elements as follows:

L = latitude of observer,
δ = corrected declination,
h = true altitude,
λ = hour angle,
z = azimuth,
} of a heavenly body.

For convenience sake we will refer to the east and west line of the compass as the *equator*, to its north and south lines as the *meridian*, and to its north and south points as the *poles*.

Problem 1.—To find the azimuth (z), the latitude (L), the declination (δ) and the altitude (h) being given.

Solution.—On the ream of the compass mark L and δ in their proper places with reference to the equator; also mark on it h, counting the degrees from the equator *northward*; then take with the dividers the arc Ph (= the zenith distance) and lay it off from L northward and southward to the points D and S respectively; next find point i, which will be at the intersection of the line DS with the radius drawn to L. Through i draw a horizontal and mark point r on the meridian; also draw horizontals through δ, and D and S. From r as a center, and with half the vertical distance between D and S as a radius, intersect the horizontal through δ to the right of the meridian when the heavenly body is to the east, and to the left when it is to the west. Through the center of the compass draw a line parallel to that connecting r and the point of intersection on the horizontal through δ, and you will have the azimuth in the proper direction and amount as read on the compass.

Care must be taken in plotting the elements L, h, D and S at equal distances from the center of the compass, which is not difficult when the latter is provided with full line circles at the graduation, as in Fig. 2. Not all chart compasses, however, have these full line circles.

Ex. 1.—Given $L = 35°\ 30'$ N. and $h = 18°\ 36'$; find z when $\delta = 22°$ N. with the body to the west, and also find z when $\delta = 22°$ S. with the body to the east.

As seen in Fig. 2, z = N. 75° 3-4 W. approx. when the body is to the west in declination 22° north, and z = S. 43° 1-2 E. approx. when the body is to the east in declination 22° south.

Ex. 2.—Required the azimuth of Sirius (α Canis Majoris) to the east of the observer in latitude 24° 30′ S., the corrected altitude being 30° 20′. The declination of Sirius is —16° 32′, and the resulting azimuth is S. 84° 1-2 E. approx.

Fig. 3 compass being from an English chart, the magnetic meridian is used in solving this example in place of the true meridian, and the azimuth S. 84° 1-2 E. is of course the true and not the magnetic azimuth.

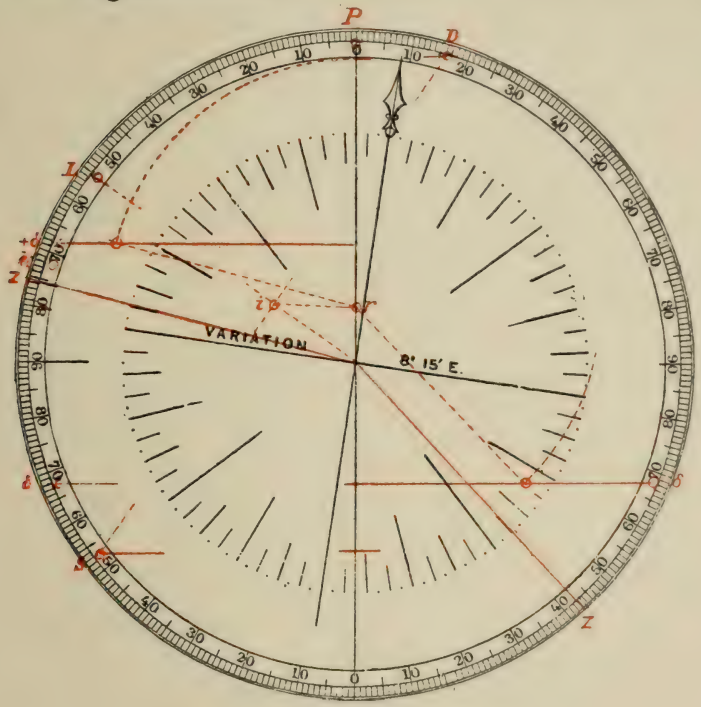

FIG. 2.

This example incidentally shows that for the solution by compass the U. S. chart compass is superior to the English, as by the former the true and magnetic azimuth can be immediately read off.

Problem 2.—To find the amplitude of a heavenly body at rising or setting, L and δ being known.

Solution.—This is merely a particular case of Problem 1, h being zero, hence D and S are distant 90° from L northward and

southward and point r falls on the center of the compass. Half the vertical distance between D and S is equal to the horizontal distance between point L and the meridian, therefore all that is needed is to take this distance with the dividers and to intersect with it from the center of the compass the horizontal through δ. The connecting line between this point of intersection and the

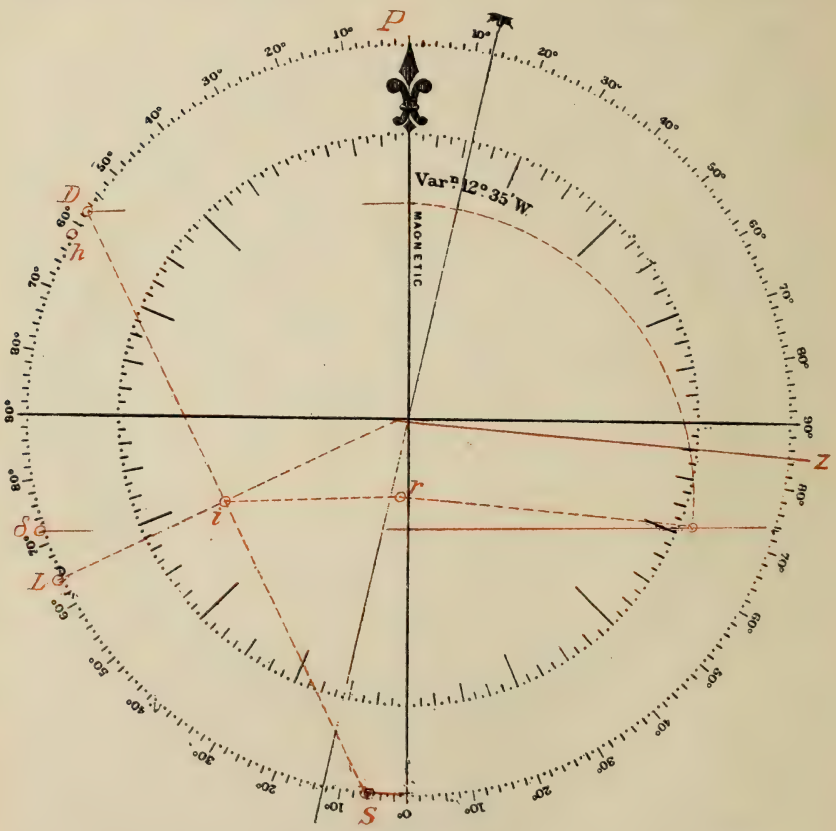

FIG. 3.

center of compass will show the true amplitude A, which will be north when δ is north and south when δ is south.

Example.—Find the amplitude of the sun at setting in latitude 45° 1-2 N., the declination being 13° 20′ S. The resulting amplitude (see Fig. 4) is W. 19° 1-4 S. approx.

Problem 3.—To find the hour angle (λ), L, δ and h being given.

On account of the small size of chart compasses the hour angle cannot be read off with sufficient accuracy to make the solution by compass of much practical use, and the problem is included in this paper merely to show how it could be solved more accurately on a graduated circle of larger diameter.

Solution.—The hour angle in arc is found by a process identical with that for finding the azimuth from L, δ and h, with this

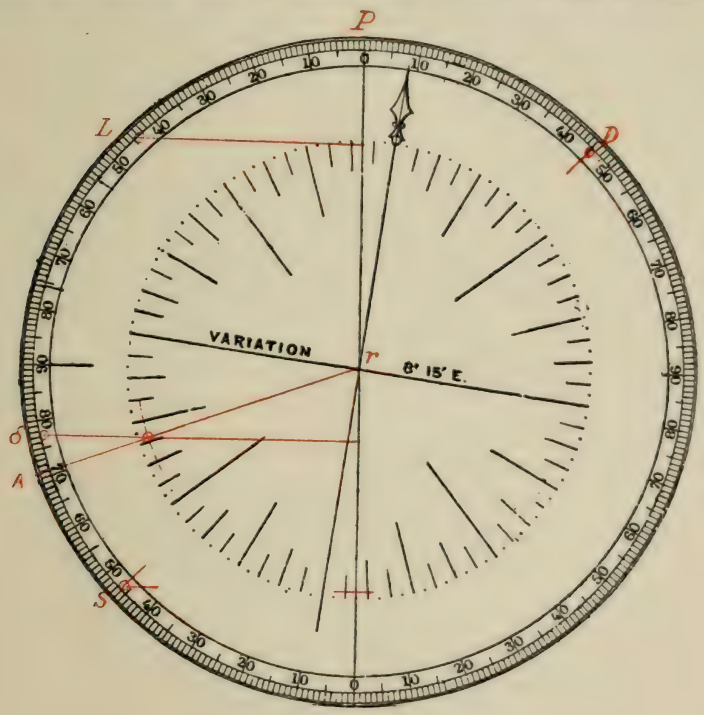

FIG. 4.

difference, that instead of laying off the arc Ph (the zenith distance) from L, the arc $P\delta$ (the polar distance) is laid off northward and southward from L to D and S respectively; and instead of intersecting the horizontal through δ with half the vertical distance between D and S, the horizontal through h is intersected with that distance. The hour angle is always to be counted from the north pole. (Care must be taken to lay off D and S exactly,

which can easily be tested, as one is equal to the difference and the other to the sum of L and δ, as read on the compass.)

Ex. 1.—Find λ when $L=65°$ N., $\delta=22°$ N. and $h=15°$ 3-4, the body being to the west.

As seen from Fig. 5, the resulting compass reading of λ is S. 80° W., which, counted from the north pole, corresponds to an arc of $100°=6$ h. 40 m.

Ex. 2.—Find λ when $L=12°$ S., $\delta=6°$ N. and $h=18°$ 06′. The resulting hour angle (see Fig. 6) is $70°=4$ h. 40 m. approx.

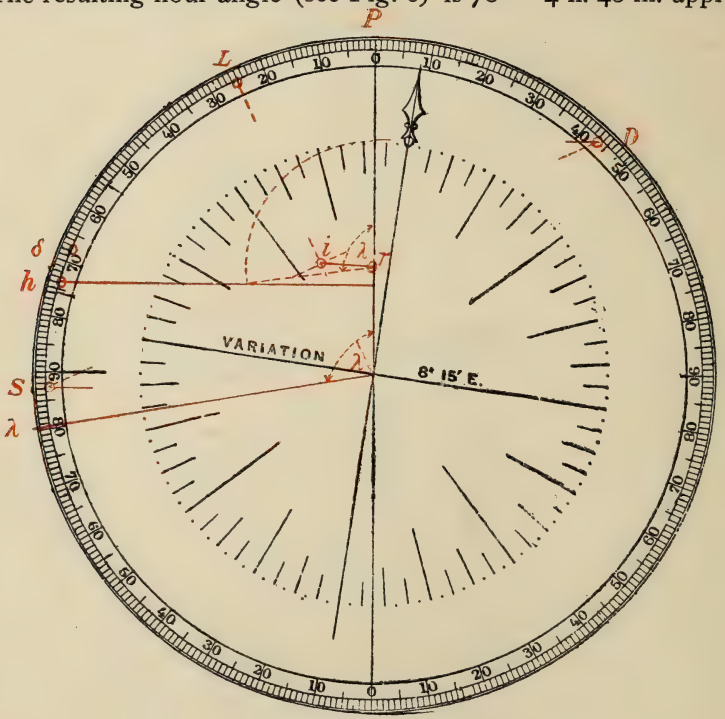

FIG. 5.

Problem 4.—To find the hour angle (λ) of a heavenly body at rising or setting, L and δ being known.

Solution.—This is a particular case of Problem 3, h being zero. Hence after finding D and S and point r as in the preceding problem, intersect the equator with half the vertical distance between D and S, and through center of compass draw a line parallel to that connecting r and the point of intersection at the equator. Thus,

if in Example 2 of the preceding problem we make $h = 0°$, the resulting hour angle λ would be $88° 3\text{-}4 = 5$ h. 55 m. approx.

Any one who has arrived at an understanding of the processes with the compass will find no difficulty in applying them to various other problems involving the determination of a side of the astronomical triangle, and there appears to be no need of enlarging further upon the subject beyond showing how to measure on a compass-rose the great circle distance and course

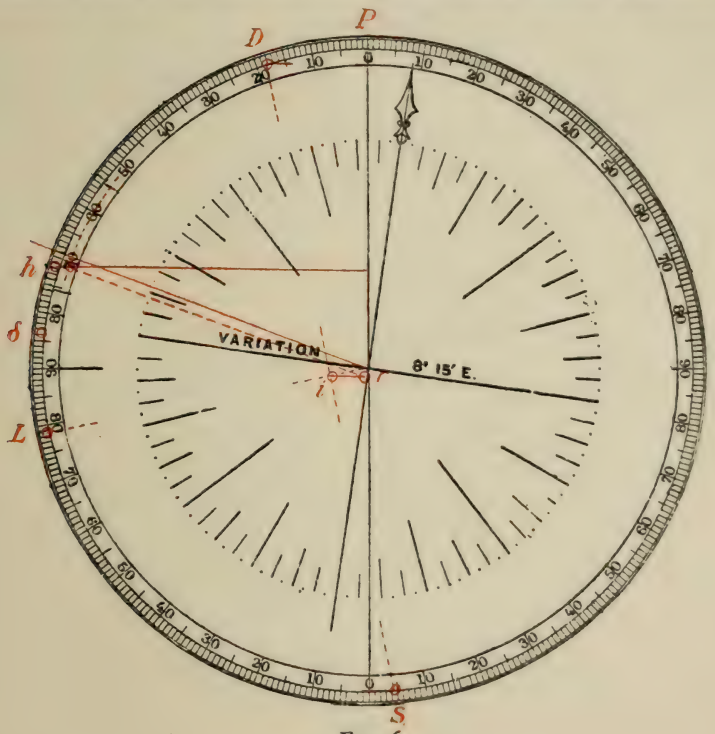

FIG. 6.

from one place to another on the surface of the earth, a problem the solution of which is identical with that of finding altitude and azimuth from latitude, declination and hour angle.

Problem 5.—To measure the great circle distance and course from a point off the Cape of Good Hope in lat. 34° 25′ S., long. 18° 30′ E., to a point at the entrance into Chesapeake Bay in lat. 37° N., long. 75° 57′ W.

Solution.—Designating the latitude of the point of departure by L' and that of the point of destination by L'', mark L' and L'' on the ream of the compass (Fig. 7), then lay off the arc PL'' from L' northward and southward to D and S, and find points i and r as in the preceding problems. From r lay off a line making with the meridian an angle corresponding to the difference of longitude between L' and L'' ($94° 27' = \lambda$) counting the degrees from the north pole, and intersecting this line with

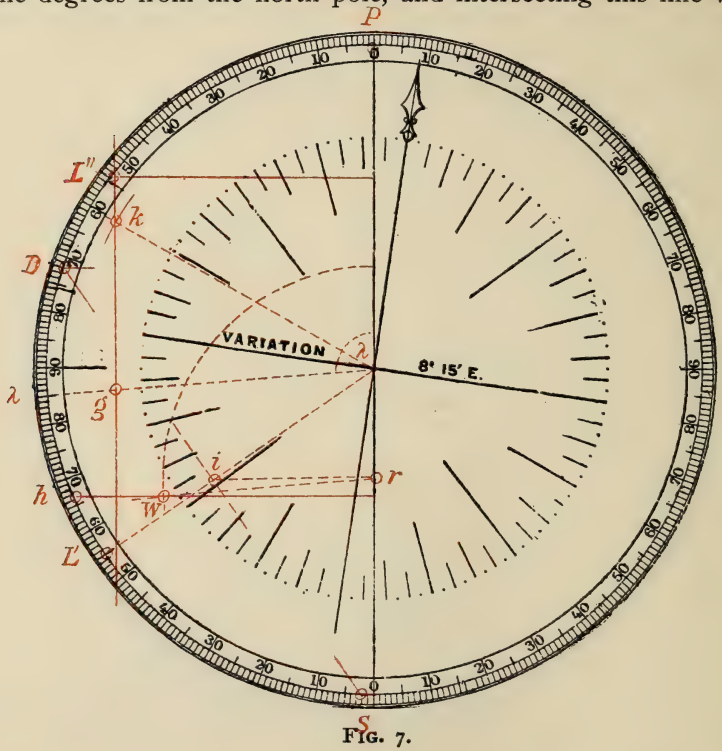

FIG. 7.

half the vertical distance between D and S (at w). Through w draw a horizontal and read the latter's intersection on the ream of the compass (at h), which, counting from the north pole, will show the required distance, in this case about 113° or 6780 nautical miles. The course is now obtained like the azimuth in Problem 1, or when not too near 90°, more conveniently, as follows: On the radius to λ lay off the horizontal distance between L'' and the meridian, this will give point g; through the

latter draw a vertical and intersect it from the center of the compass with the horizontal distance between *h* and meridian at *k*. The radius through *k* will show the course required, in this example 60° very nearly.

The solution of the examples given shows what can be accomplished with so simple a means as a chart compass, and it is surprising how good results can be obtained, as any one may ascertain from trial, if the compass is accurately constructed and provided with a full line ream so as to facilitate the correct marking of the several elements, and if a sharp-pointed pencil and good dividers are employed.

DISCUSSION.

Torpedo-Boat Policy. (*Continued from page 67.*)

Assistant Naval Constructor H. G. Gillmor, U. S. Navy.—The author recognizes two uses of torpedo-boats. Is the same kind of boat, that is, one with the same features of speed, armament and coal capacity, best adapted to these two purposes? Is it the custom to embody in the design of coast defense vessels the same features in the same proportions that they are embodied in the cruising battle-ship? Are not the relative values of the different features in torpedo-boats which are to form a part of the coast defenses essentially different for those in torpedo-boats which are for service with the offensive arm—the cruising navy? May not the relative values of the features of a torpedo-boat of the coast defense depend upon the peculiarities of the locality in which it is intended to act?

It is to be feared that the purpose of torpedo-boats, "to destroy the enemy's ships," has, in some cases at any rate, been lost sight of, efforts being directed to the production of "the fastest boat of her size in the world" or "the fastest vessel afloat." The necessity for surprise has certainly been lost sight of in a great many cases.

It is not the intention to commence here the contention regarding the introduction of the ram, but it would seem that the proposition to make a ram of a vessel whose ratio of length to beam is ten to one and whose difficulties of local weakness are so great is ill-advised. Upon the weight allotted by the author—and it is very doubtful if it would be sufficient for the purpose—an additional 3-pounder and about a hundred rounds of ammunition could be installed, and the chances of a disabling shot from it would be considerably greater than the chances of ramming, even could that be attempted with reasonable safety to the ramming vessel.

The case cited of the Audacieux and the Chevalier should prove instructive. The angle belt of steel with a wood backing which the author speaks of was a wood chafing batten about 3 inches square, secured to the sides of the boat with two light angles, the whole being intended as a protection when lying alongside a landing or a ship. That so light a protection should have produced such disastrous results to the rammer may be taken as an index of the amount of local strengthening necessary to make ramming possible with reasonable safety.

The author has laid great strees upon the question of endurance. The method which he adopts in making comparisons of maximum power is extremely misleading and affords a very poor measure of the relative endurance of boats of different types, because of the very great variation in the maximum horse-power among them. There is usually no relation at all between full speed endurance and economical endurance in two boats unless they have exactly the same speed features. That the maximum power will only be used for short spurts and that the long distance work will be done at the economical speed is pretty well conceded.

What, then, is the justice of a comparison of a 5½ hours endurance at full speed of a thirty-knot boat with the 17 hours endurance at full speed of a twenty-six-knot boat of about the same size, when the endurance of the first at cruising speed is about one-half that of the second, instead of about one-third, as a comparison on the full-power basis would show? The column in the tables devoted to pounds per I. H. P. at the maximum power is equally misleading. The coal consumption trials of the Ardent and the Starfish, the results of which were published in *Engineering* some time ago, showed that at thirteen knots, the assumed economical speed at which the trial took place, the Ardent would steam 28½ nautical miles per ton of coal, her full capacity giving her, therefore, an endurance of 2000 nautical miles; and the Starfish would steam 39.6 nautical miles per ton of coal, so that her full capacity would give her an endurance of 2360 nautical miles. M. Normand, in his article before the Association Technique Maritime last year, gives the results of the coal consumption trials of the Forban at ten knots, her economical speed, and from these results the endurance of the Forban at ten knots would be about 2360 nautical miles. This would tend to show that in the matter of endurance size does not possess so great an advantage as might at first sight appear.

The speciousness of the author's argument in the comparison of a 22½-knot boat with a 30-knot boat will be evident by applying it successively to boats differing in speeds by successive equal amounts down to the speed of 12 knots which he assumes as the speed to be used prior to discovery. It is to be noted that this speed of 12 knots assumed by the author as the advisable speed prior to discovery is entirely arbitrary. It is obvious that the speed at which flaming at the funnels and surface disturbance begin to appear to an extent endangering the secrecy must depend upon the approach to maximum power and speed, and while it might be 12 knots in one boat, it might be 20 in another. This in itself would vitiate the comparison between the 22½-knot boat and the 30-knot boat, were it otherwise logical and consistent.

The author has made much of the maintenance of speed in a seaway. Just what are the differences between the performances of a torpedo-boat of one hundred tons and a destroyer of two hundred tons in a seaway and in still water has never been determined. It is conceivable that the conditions of sea most unfavorable to the destroyer might be very much less so to a boat of one-half its displacement and two-thirds its length; just as with ships in squadron it is sometimes found that seas most unfavorable to the larger ships have comparatively little effect upon the smaller. In any event, the difference in the performance of the two must be affected through difference in freeboard and the effect of dead weight in maintaining speed in a seaway. Then, too, there is always the question whether, in circumstances of weather seriously affecting the speed, the larger vessel would be in a postion to attack and destroy the smaller.

A careful perusal of all that precedes the author's conclusion as to "the best type of torpedo-boat" fails to bring the conviction beyond question that a boat of one hundred and fifty feet length and one hundred and twenty tons "would fill all the requirements." Even if it would fill all the requirements, is it the boat which would *best* fill all the requirements?

Should we have the same boat for both offensive and defensive purposes—the same for the defense of New York, service in the Chesapeake Bay and with the fleet?

That size need not be governed by conditions of seaworthiness, within the limits of size under our consideration, has been demonstrated practically and effectively by the experiences during the past ten years of torpedo-boats varying in size from one hundred feet and forty tons upward, which have not only successfully weathered gales of great severity, but have made voyages of several thousands of miles in varieties of weather at fairly constant cruising speeds. The Batoum, the Brazilian and her two sister boats, Torpedo-boats No. 62 and No. 63 of the British Navy, boats for Japan, for China, for the Victorian Government, for India and for several of the South American States have long since exposed the baselessness of the charge of unseaworthiness on the ground of size. The possibility of seaworthiness independent of size being established, it is evident that life is no less possible to men habituated to a small torpedo-boat than to the thousands of men who yearly leave this coast and the coasts of other countries for service covering months at sea in fishing vessels whose sizes and the violence of whose motions are not greatly different from torpedo-boats, however greatly they may differ from these boats in proportions and characteristics; and that therefore this need not be taken as placing a limitation upon the size of torpedo-boats. In this connection let the remarks of Captain Eardley-Wilmot, quoted by the author on page 15, be reread. Why then "pass at once to twice the displacement at least"? Does the increase in endurance and armament necessitate this sudden doubling of displacement? Is the increase in first cost, maintenance, the number of men involved in each engagement and the loss in invisibility worth the cost?

The history of English torpedo-boat construction, from its commencement to the present (and a definite policy is not yet established) is a history of keen competition for the highest speed among a limited number of builders. There has never been a time when any type produced has been carefully and systematically tested, after training crews to the peculiar life required by the service, to determine the fitness of the type for the designed purpose, and what, if any, changes might with advantage be made. The development and its course have been determined primarily and preëminently by the rivalry of a few builders of high-speed boats, each seeking to excel the speed performance of the other, regardless of economy of power; and secondarily and partially by yearly haphazard expressions of opinion by officers high in rank, based upon a week's or at most a fortnight's observation from a distance of torpedo-boats hastily commissioned, usually with raw crews and officers new to the special service, working in one kind of weather, on one portion of the coast, under wholly arbitrary rules governing their performance. They have produced boats increasing constantly in size, displacement and speed. The end has not been reached, and speeds of 32 and 33 knots are talked of.

The "torpedo-boat destroyer" is, for the present only, the last term in the ascending series of torpedo-boats. It is the logical result of the causes which have determined the course of English torpedo-boat con-

struction. Any points of superiority—and it must be admitted that there are some—which it possesses over the earlier members in the series, aside from speed, are incidental to and made possible by the increase in size which, to the English professional mind, is inseparable from increased speed; and not the prime objects sought in the design. It is speed that has ever been the will-o'-the-wisp luring on English torpedo-boat builders. What has been this "several years' experience with the type" which makes it appear "that they are just what is required for general use with the fleet"? Each in turn has come from the builder with column notices in the daily papers, to enjoy for a few days or a few weeks the distinction of being the "fastest boat in the world" or "of her class," and then be commissioned and go to serve with the fleet under peace conditions as one of the cruising fleet, with no more effort to determine her fitness for her definite purpose than was the case with her many predecessors. One year it is a boat of one hundred and ninety feet and 27 to 28 knots that is "just the thing," the next a boat of 200 or 210 feet and 30 knots, and the next a boat of 220 feet and 31 or 32 knots. Is there any reason to believe that the end has been reached, or that five years hence the same treatment of the subject will not demonstrate equally conclusively that "just the thing" is a boat of 350 tons and 39 or 40 knots?

It is to be feared that the key to the author's conclusions is to be found in this question which the author propounds in his introduction—"Which of these different types shall we copy after for the present?"—rather than in the incomplete reasoning which precedes them. Expressed in a few words, the author's conclusion is that we should start in this mad race for torpedo-boat speed about where England now is and accept their latest type in one case, and in the other almost a duplicate of the last thing which the English newspapers chose to call a torpedo-boat.

With regard to coal protection, all that may be said is that if the coal is in the bunkers at the time, and the striking energy is less than sufficient for the penetration of ¼ inch of steel and 2 feet 6 inches to 3 feet of loose coal, the boat may be saved an occasional shot. It is, however, to be remembered that coal is carried for use and not for protection and may, probably will not, be there when needed and that the top coal of the bunkers is the first used.

It would seem that the decrease in probability of complete disablement by separation of the two engines in compartments longitudinally is considerably overestimated. It is to be remembered that in such a separation the vital target is considerably increased, for in boats like No. 6 and No. 7, injury of the high pressure cylinder, valve chest or the steam supply pipe of either engine would result in the disablement of both on account of the loss of pressure through the opening so made. In the boats designed by the Navy Department, means are provided for closing the stop-valves of either engine from the deck, but even with this arrangement there would be an interval during which both engines would be disabled. When we consider that the chances of such a hit being made are practically doubled by the arrangement suggested, whatever arguments there may be for the arrangement on the ground of increased convenience

or better distribution of weight, there can be none on the ground of increased immunity from disablement.

Lieutenant A. P. Niblack, U. S. Navy.—In no country in the world do the technically informed officers control the questions of types of ships and the shipbuilding policy. These are largely determined by political, financial, and commercial considerations. Nevertheless, it is of great interest to know what we ought to hope for, and no one is better qualified, in a way, than the essayist to set us straight in the matter of torpedo-boats. As an observer and in no sense technically informed, I must express my regret that in the limits of the essay so much was left unsaid which it appears to me ought to be considered under the title "Torpedo-boat Policy."

Both the navy and the shipbuilding firms in the United States have figuratively "cut their teeth" on a heterogeneous lot of steel cruisers, and at present the result is: 1st. Our new battle-ships of the Alabama class are about as nearly ideal for our purposes as human ingenuity can devise; 2nd. In the monitor type we have the highest development of inner coast line and harbor defense ships, and 3rd. When we resume building cruisers, we can, and doubtless will, so profit by the past and by results abroad as to assure the adoption of a type suited to our particular needs. It appears that in the torpedo-boat question we must also go through the teething period. Certainly the present programme is indefensible from a technical standpoint, however necessary and wise from a commercial or financial point of view.

It is a pity we cannot inaugurate at once what we, as a sensible, practical, thinking people, must ultimately come to in torpedo-boats, as we have in battle-ships and monitors (and ultimately will in cruisers), viz. torpedo-boats must suit tactics and policy, and designs must not vary at the whim of boards, designers, or contractors. The important thing is not that each ship or each torpedo-boat must be the latest thing in every detail, but that the fleet shall be homogeneous.

Effective torpedo-boat service can only be organized, carried on in time of peace and operated in time of war by boats manœuvring in company with a fixed system of tactics and with a perfect similarity in type. We have set an example to the world in common sense by limiting the speed of battle-ships to 16 knots: why not stop the equally indefensible high speed for torpedo-boats? The essayist shows conclusively its folly, but fails to drive home the real conclusion. Let us set the limit of speed for the 250 to 300-ton boats at 26 knots—good, honest, reliable *sea* speed without any question. Let us limit the first-class boats at 24 knots. This illusive and always increasing variable once fixed we may grasp the substance and not the shadow.

The true policy is to build torpedo-boats in groups either at the same time or from year to year, each group having identical tactical and manœuvring qualities, interchangeable parts, and being as nearly alike as possible.

The tests applied to the torpedo-boats of the world, which the essayist

passes in review, is illusive because he fails to appreciate the wonderful system of Germany, which country has grasped the fundamental principles thoroughly. Their system is to build boats in groups, roughly, one division boat corresponding to an English "destroyer," and seven or eight first-class boats. Six torpedo-boats and one division boat form the group unit, with one or two first-class boats in reserve to keep the number up to six. The division or "mother" boat carries spare parts for the group and is practically flag-ship. All boats have single screws, and manœuvring qualities are easily obtained by a bow rudder in addition to the one astern. A flock of swallows could not manœuvre more adroitly at close distance than do the German boats.

In our country, manœuvring in groups from fixed bases, laying up in groups, scouting in groups, accompanying squadrons in groups are as clearly the real policy as for Germany. This building of individual ships and of torpedo-boats to break records and advertise particular shipbuilding firms is a great thing commercially, but not from a military standpoint. Speed costs tremendously. Four torpedo-boats that we really want, for the same money that three cost of a type we don't want, is a proposition to be commended to those who have the spending of the money. Why not use good, hard common sense and stop this folly now, instead of waiting two or three years? We don't buy race-horses for the cavalry. Of all sciences, cavalry tactics imposes definite conclusions, and so does torpedo-boat tactics, if we will only think about it.

I am not so sure that twin screws are essential, although they are a great comfort. As for strengthening the bows for ramming, I rather think that for group manœuvring the continual danger to consorts is not worth its offensive advantage in the remote chance of ramming an enemy's torpedo-boat. It would seem to me better policy to make the bow light and to give armor protection amidships at the water line, especially in view of the increased penetration and rapidity of fire of modern small arms and machine guns. Coal endurance, reliable sea speed, and seaworthiness are the benefits we may look for in reducing the speed.

I think the essayist has either somewhat lost sight of the tactical side or else does not believe in its efficiency. He is quite right in saying that the Austrian Viper does not handle well because she has only one screw; but the Natter, built by Schichau in competition with the Viper, has only one screw also, but by means of a forward rudder she handles splendidly. After all, six torpedo-boats of inferior speed and older type, but all identical, are worth more than six faster ones of heterogeneous types, unless tactics is a dream of theorists.

The Composition of the Fleet.

[See No. 79.]

Lieut. J. M. Ellicott, U. S. Navy.—I presented my essay on the composition of the fleet under a conviction that the time had come when not one, but many, even all, officers of the Navy ought to give their views upon the number and types of vessels which should make up our naval establishment; hoping that from the presentation of such views there might be deduced a sufficient consensus of opinion to command the attention of our legislators in framing and maintaining a building program. My views, as those of an individual, I presented briefly, trusting that others would round out the subject by discussion. As it has been impossible to reach more than a small percentage of officers with advanced copies, and as these were distributed in the summer season when the mind seeks relaxation and rest, I hoped that my essay may yet "draw more fire." I am gratified to find that my views are so little at variance with a majority of those expressed in the discussion, and I beg room in the pages of the Proceedings of the Institute for some words to those who seriously differ from me.

Lieut.-Commander Wainwright seems willing to allow the building up of our navy to be determined by "the opinions of our legislators for the time being." Those opinions are happily trending in the right direction at present, but such haphazard building will not give us a homogeneous fleet, nor keep it up to any constant standard of efficiency. He also advocates basing our program upon the "present needs of the country," in which case we will always be at least five years behind our needs, for a battle-ship takes five years from appropriation to completion. When it is remembered that we are a child among nations, growing at an enormous rate, and in a time when international relations around us are strained, almost to breaking, and enterprises are projected over which we should, for our welfare, exercise paramount control, it must be conceded that we have *got* to speculate to a certain extent upon future requirements in order to keep abreast of the needs of the country.

Lieut.-Commander Wainwright states that "the most expensive way of mounting guns, when due weight is given to their proportional effectiveness, is on monitors." I regret that I cannot now get figures upon the subject, but I say without hesitation that I believe this statement can be proven to be wholly and vastly wrong. We now have guns of the same calibres and latest construction mounted both ashore and upon monitors. Mr. Wainwright is in a position to get full information of the expense in each case, and I beg that he will look it up and state it.

Does Lieut.-Commander Wainwright believe that we will ever have "adequate fixed defenses"? Does any military or naval man fully believe it? I think not. On the contrary, I believe we all know that we never shall. "Adequate fixed defenses" for New York City will include heavy modern batteries at Sandy Hook, Romer Shoal, Forts Hamilton and Wadsworth, Governor's Island, Willet's Point, Fisher's Island, Plum Island, and Little Gull Island. A few of these we have, and all are projected, but there is not a shadow of a chance of the scheme being com-

pleted within fifty years. Had we not better put such batteries on ten monitors in the meantime, ready to be mobilized in time of war wherever in this district they are needed?

I believe that the views expressed by Lieut.-Commander Wainwright, Commander Goodrich and others against commerce destroying are more sentimental than military. It is looked upon as the resort of a weakling among nations because the most apparent damage is to the commercially strong. Moreover, its effect upon the conduct of a war is indirect and not easily measured, and it has never been systematically projected and maintained by a nation strong enough to do so. The demands of trade control the actions of nations more and more every day. The nation which first compels the voice of trade in the other to cry out against a war will have won half the fight. Supposing a nation at war with Great Britain; would it not be looked upon as folly if the former allowed the latter's thirteen million tons of shipping to sail the seas unmolested?

I do not think that my statement about army scouts will suggest to any one who carefully reads the paragraph that I confuse army scouts and spies, but my suggestion that scout vessels "should be modeled so closely after ocean coastwise passenger steamers as to be readily mistaken for them" does place them more in the category of spies than scouts. I am ready to concede that they might, therefore, be designated "spy vessels," yet I think that we would prefer to call them scouts and leave the enemy to use the other designation. Whatever we call them, I reiterate my belief in their importance.

I cannot admit that I have failed to grasp the true use of the armored cruiser, but I overlooked the important use for her which Lieut.-Commander Wainwright well states, and which might briefly be called reconnoissance in force. When she returns upon the fleet from such reconnoissance, however, she is bound to find her place in the line of battle very much as I have suggested. I advocated the New York in ignorance of her many developed shortcomings. After much discussion at the War College last summer a preponderating opinion developed that the Olympia, with 1500 to 2000 tons more given to protection, making her about 7500 tons displacement, would make a good type. Lieut.-Commander Wainwright says "the necessary qualities have been obtained in other countries by building vessels of less than 7000 tons." If he will name the vessels he has in mind and state their offensive and defensive qualities in further discussion, his information will, I know, be read with the deepest attention and interest.

Lieut.-Commander Wainwright is correct about the necessity of improving some of our canals and interior waterways for torpedo-boat navigation. Let us insist that this be done and not "be satisfied with inferior boats."

I challenge the statement that "a portion of the public view the navy with suspicion and suggest ambitious motives," and that my paper gives cause for such suspicion. What possible ambition can we have except to see our magnificent country sufficiently armed to be unassailable by inferiors, and to have no superiors; to assert a dignity, an independence and a control in the Western World with the confidence of being able to maintain them; and to insure the continued advancement and civilizing

influences of republican institutions. Increase in our naval establishment can only mean to individual officers more arduous and continual duty afloat. The view Lieut.-Commander Wainwright takes sounds medieval.

Lieut.-Commander Wainwright condemns my "ambitious program," but let it be noted that he says "we need more battle-ships, more armored cruisers and many more torpedo-boats," and I hope that these statements, coming from him, *will* have "very serious weight with those who have the shaping of our naval shipbuilding policy."

To a great majority of readers the language with which Commander Goodrich opens his discussion must seem so harsh as to discount the value of his criticism. He even impeaches the judgment of the Board of Control of the Institute in awarding the essay honorable mention. It was at my written request that Commander Goodrich's discussion was solicited by the Institute, and I made the request because I knew that his views were radically different from mine. I fully understand, therefore, that his harsh words are due to the very positive opinions he holds upon the subject of the essay.

He first asserts that there is no evidence that "we are in daily jeopardy of national humiliation," etc., because of our small navy. Is there a legislator or a military man, is there a thinking man in our whole country who has not felt more or less misgiving within the past year about our being able to maintain our loudly proclaimed attitude in the Venezuela boundary dispute? Was there a naval man who did not realize the jeopardy of humiliation in the matter about a year ago when England called into being, without drawing from her cruising fleet, a flying squadron superior to our whole navy, and dispatched it—Heaven only knew where, during the white heat of the controversy? Does any American believe that any other power would have been so tolerant and calmly argumentative as England has been in the matter? Does not all Europe stand aghast to-day at the position England has accorded to us in the control of the affairs of our American neighbors?—the Continental press declaring that European states cannot abide by it.

As evidence of our daily jeopardy of national humiliation because of an insufficient navy I beg leave to cite the following occasions:

1. In 1795, when we felt compelled to pay one million dollars in tribute and sign a treaty guaranteeing $22,000 annually to Algiers to spare our commerce because we had not a navy sufficient for its protection.

2. The impressment of American seamen by the British, culminating in the wanton capture of the Chesapeake by the Leopard in a time of profound peace (1807), when we could do nothing for redress but issue a proclamation prohibiting British warships from entering our ports.

3. The drawn fight of 1812, when we felt compelled to accept terms of peace without adjustment of the cause for which we fought, because, despite the brilliant victories of our seamen, we had not ships enough to cope with the enemy, and ships could not be built in a day.

4. The wholesale shooting in Santiago de Cuba of American citizens taken on board the Virginius in 1873, after a summary and farcical court-

martial in direct violation of our treaty with Spain. This massacre was only checked by the arrival of a *British* war vessel, and, in spite of our strenuous efforts to galvanize our decaying naval hulks into a semblance of life and strength in a demonstration at Key West, it is doubtful if we would have gotten the partial reparation we did had not Great Britain's claim been the same as ours.

5. The hunting down and killing, in the streets of Valparaiso, of sailors from a United States man-of-war in 1891, and Chile's insolent attitude in the matter, which was unquestionably born of her belief in our naval inferiority.

Commander Goodrich says "Mr. Ellicott's plan rests upon a policy which he thinks the nation should adopt." On the contrary it rests upon a policy which the nation *has* adopted, and which is no departure from the teachings of Washington, but the amplification of those teachings commensurate with our national growth. No man realized the value of a naval force more than did Washington, and, when President, he was continually urging upon Congress the importance of building up a navy. These are some of his "teachings" in his own words, and one statement I take the liberty of italicizing:—"To an active, external commerce the protection of a naval force is indispensable." "Will it not be advisable to begin without delay to provide and lay up the materials for the building and equipping of ships of war, and to provide in the work by degrees in proportion as our resources shall render it practicable?" "*To secure respect to a neutral flag requires a naval force organized and ready to vindicate it from insult or aggression.*"

I confess that I am utterly unable to comprehend Commander Goodrich's fine distinction between coast and harbor defense. When our mobile fleet goes to sea to meet the enemy it is defending our harbors and thereby our coast. It is the multitude of our harbors and their wide distribution along a continuous coast line which renders us so vulnerable. We cannot tell where the blow will fall. Our fleet of battle-ships, be it eight or twenty strong, may, and probably will, be eluded, and a blow struck at a harbor for a base or ransom. We must have some harbor defense in addition to the fleet at sea to ward off such a blow until our fleet regains touch. Fortifications will not accomplish this; their immobility would require them to be too numerous. A monitor fleet would accomplish the purpose. It is mobile; its units able to support each other; its guns never out of range and never masked. This is not localizing our defense and scattering our forces, abandoning strategy and surrendering the command of our water approaches, as Commander Goodrich tells the Institute readers I have proposed.

"Our great contingent power" cannot be mobilized, cannot be materialized when a catastrophe is imminent. At best it brings us scanty apology and inadequate reparation for insult offered and injury done. Few statesmen will have the temerity to rely upon it. We need an actual, material, mobilized naval force which will enable us not only to assert but to maintain our national policy, and which, instead of assisting us to collect damages for injuries done, will make it impossible for such injuries

to be committed. If we fear that such a naval force would be a menace to our democratic principles we have not sufficient confidence in ourselves to develop a strong national character. We must not be content to provide a future naval force "based upon the present needs of the country," nor to rely upon "our great contingent power." Washington said, "To secure respect to a neutral flag requires a naval force *organized and ready* to vindicate it from insult or aggression."

PROFESSIONAL NOTES.

COMPRESSED AIR SYSTEM ON THE U. S. MONITOR TERROR.

The use of compressed air as a motive power on board a war-ship presents several advantages over steam or hydraulic power, which render it a powerful competitor. As compared with steam, it is less dangerous, especially during an action, when a broken steam pipe might prove terribly fatal, and it enables certain parts of the ship to be kept at an even temperature, which would otherwise be rendered uncomfortably hot by the presence of steam piping. Steam and hydraulic engines, moreover, require exhaust pipes discharging outside the hull of the ship; whereas the exhaust from the pneumatic cylinders may be turned into the ship or into the outside air, as may be most convenient. There are certain localities in a ship where the exhaust from a pneumatic engine would prove a valuable source of ventilation, as, for instance, in a turret crowded with men and machinery, or in the close confinement of a steering room situated below the protective deck. As compared with hydraulic power, the compressed air system is cleaner and more convenient, and free from the discomfort that arises from the leaking of hydraulic pipes and cylinders. There is immunity from freezing. Leakage is not attended with increase of temperature, as with steam; or flooding of the compartment, as with the hydraulic system. There is less danger of break-downs when starting up or stopping motors suddenly than in the other systems.

The U. S. Monitor Terror is the first vessel to be equipped with pneumatic steering engines and pneumatic operation of turrets. The recent tests were highly satisfactory.

The air for driving the various pneumatic devices is compressed by two separate engines, one being placed in the hold near the forward turret and the other near the after turret on the berth deck. The working pressure is 125 pounds per square inch, and there is no reservoir for the air except an eight-inch pipe, which runs through the vessel and supplies the two turrets and also the steering device in the steering room at the extreme after end of the ship. These two engines supply sufficient air for turning the turrets, elevating the guns, lifting the ammunition into the cages, raising the cages to the breech of the gun, ramming home the charge, closing the breech, checking the recoil, and lastly, and most important operation of all, steering the ship itself.

The two turning engines are placed upon the floor of the turret, one on each side of the big guns. Each engine has two cylinders, 8 inches in diameter by 14 inches stroke. A worm on the crank shaft operates a set of gears by which the power is multiplied many times over before it reaches a driving pinion, which, in common with the engine and gears, is firmly bolted to the framing of the turret and of course turns with it.

The pinion meshes with a large circular rack which is bolted to the deck of the ship and lies immediately within the circular steel track upon which the turret rotates. The engines are controlled by suitable levers and hand wheels situated within easy reach of the officer in the sighting hood, the latter being placed over and between the guns.

The elevation and depression of the gun is effected by means of a massive ram, which is hinged to the floor of the turret and bears against a shoe on the under side of the gun carriage near the breech of the gun. On each side of the turret is a cylinder containing glycerine and water, a portion of which, when the gun is to be elevated, is forced by compressed air into the ram, the supply being regulated by valves which are operated by means of levers in the sighting station above mentioned.

Immediately below the turret is the handling room, adjoining which are the magazine and the shell rooms, with which it communicates through doorways which, when not in use, are closed by water-tight doors. Directly below the center of the turret is a pneumatic loading machine, which rotates upon a vertical shaft, and may be swung to the right or left as desired. The 500-pound shell and the cartridge, the latter in two parts, are run out from their respective rooms on an overhead trolley and placed in the tray of the loading machine. The tray is pivotally attached to the body of the machine by a set of parallel rods and a lever which carries at its inner end a circular rack. Above the rack is an air cylinder whose piston rod terminates in a vertical rack which engages the circular rack before mentioned. By admitting air at the top of the cylinder, the tray with its load is raised to the required height and the latter is placed in the pockets of the loading car.

There are two of these cars, one for each gun, and they travel upon two vertical hoists or trackways which lead up to the breech of the guns. The hoisting is done by two pneumatic cylinders located on the floor of the turret between the guns. Attached to each piston rod and beneath each cylinder is a set of multiplying sheaves. Over these passes a wire rope, one end of which is fastened to the floor of the turret, the other end being carried to the loading car. The speed of the rope is so adjusted that the full stroke of the pistons will serve to hoist the loading car from the floor of the handling room to the breech of the gun. The loading car contains three parallel pockets, which rotate within the frame of the car, friction wheels being interposed to facilitate the movement. One of the pockets carries the shell and the other two the powder charge. The car is automatically brought to a stop with the lowest pocket containing the shell immediately in line with the breech of the gun.

It is then pushed home by a telescopic rammer which is operated by compressed air, the valve which admits the air being worked by a man who sits astride of the cylinder. The rammer is carried by a bracket bolted to an extension of the gun carriage, and it is consequently held at all times in true line with the bore of the gun. After the shell has been rammed home, the loading car is rotated and the two sections of the powder cartridge are brought successively opposite the breech and pushed home. The breech plug is then swung round, thrust into place and locked.

The recoil of the gun is controlled by two pneumatic cylinders, 14 inches in diameter and 40 inches in length. The cylinders are secured to the gun carriage and the pistons to the gun. Before firing, the pressure on the recoil side of the pistons is about 500 pounds per square inch. As the gun recoils, carrying the pistons with it, this pressure is rapidly

increased by compression. To reduce the pressure at the end of the recoil, a tapered rod is provided, which passes through the center of the piston and allows the air to pass more and more freely to the counter side of the piston as the gun returns. The residual pressure is utilized to return the gun to its firing position. Perhaps there is no part of the many operations performed by compressed air on the Terror in which the power shows to better advantage—the elasticity of the air preventing all shock and providing an easy cushion in the recoil and counter recoil.

The last and most important duty performed by the compressed air is that of steering the ship. The work is performed by two long horizontal cylinders arranged one on each side of the tiller. They are provided with a common piston rod, in the center of which is a hollow crosshead in which the tiller is free to slide as it is swung right or left by the movement of the pistons. Compressed air is admitted to the outer ends of the cylinders by means of a D valve, the air being simultaneously admitted at the back of one piston and exhausted from the other, according as the helm is to be put over to port or to starboard. Air is also admitted at all times at the inner ends of the cylinders, and a pipe connects them, so that as the pistons move, the air may flow freely from the inner end of one cylinder to the inner end of the other. In the center of the connecting pipe is a bypass valve, which is open when the tiller is being moved, but closes when it has been traversed the desired angle and holds the air imprisoned in the cylinders, thus locking the tiller between two elastic cushions. The heavy shocks to which the tiller is subject in rough weather will thus be received and absorbed by the air, and the framing of the ship will be proportionately relieved of the strain.

Provision is also made for steering the ship by electricity or by hand power. For the latter purpose an auxiliary tiller, which can be quickly coupled to the rudder head, is placed above the pneumatic cylinders. It is operated by means of an endless wire rope which passes through sheaves at the end of the tiller and round a drum attached to the deck beams overhead. The drum is controlled through a chain and sprocket gear by a large hand steering wheel shown in the engraving. The steering may also be controlled by an electric motor which is located in the same compartment. The shaft which operates the valve of the pneumatic cylinders has three clutches upon it, by manipulation of which the steering may be carried on by electrical connections from the pilot house or from either of the turrets. During the tests of last November the rudder was turned from hard a-port to hard a-starboard in the very short time of six seconds. In testing the turret engines, the air was exhausted from the receiver and the compressor was started. In a few seconds the 250-ton turret began to move, and in 45 seconds the full working pressure of 125 pounds to the square inch was realized. It took 52 seconds to swing both turrets completely around their full arc of training.—*Scientific American.*

LUBRICATING SHIPS' BOTTOMS TO INCREASE SPEED AND PREVENT FOULING.

The invention of a simple and inexpensive device for accelerating the speed of ships and preventing barnacles and corrosion has recently been brought to the attention of the Chief of Construction and other officials of the Navy Department in Washington.

The invention consists of a mechanism which envelops the submerged portion of a ship with a film of oil, thus reducing friction and overcoming to a large degree the resistance of the water.

A series of iron flanges are fastened along the bottom and sides of the ship below the water-line, in which are inserted sheets of woven wire netting, lathing or sheet iron, covered with an absorbent composition saturated with oil. The flanges have a semicircular covering on top, below which runs a finely perforated pipe which ejects a fine spray of oil against the inside of the flange and on to the sheets, from which it spreads downward.

The oil is not carried away by the water, but through capillary attraction is spread, thus keeping the ship's hull greased without any waste of oil. It is said that the composition is a perfect carrier of oil under the surface of the water, a feature which has never before been achieved and which will make oil perform below the water-line the same service that it does in quelling a rough sea.

It is said for the invention that, applied to any vessel, either steam or sailing, it will increase the speed by at least twenty-five per cent. without augmenting the amount of machinery or the expenditure of fuel. Another and most valuable feature claimed is that it will prevent the growth of barnacles. These enemies to ships' hulls necessitate frequent dry-docking and scraping, at large cost.

The inventor also declares that the fatty composition will completely prevent corrosion of hulls.

The oil used is crude petroleum, and is supplied to the pipes by tanks and valves located above the water-line. The system is so arranged that in rough weather a large quantity of oil can be discharged along the sides of the ship and distributed over the surface of the water, thus providing a more effective method of greasing and smoothing high seas than any yet devised.

The covering composition is an oleaginous preparation of tallow, calcined carbon and several other ingredients which the inventor keeps secret. It is said that it hardens in the water and cannot wash off, and can be applied to submarine war projectiles, permitting double velocity.

The inventor is Rudolf Altschul, a civil and mechanical engineer of New York City.

THE MIKLASCHEWSKI SIGNAL LANTERN.

These lanterns recently were put to a series of practical tests in squadron signaling. The lanterns, or rather the signals made by them, were visible at a distance of 34 nautical miles (60 versts), a distance not before attained by any lamps. The lanterns are very compact, and not large, weighing about 7 lbs. They are filled with alcohol and two kinds of powder, one of them green, the other red, secrets of the inventor, Colonel Miklaschewski. Attached to the lantern are two small rubber tubes with pear-shaped bulbs. Pressing these bulbs produces flares of red or green light. A glass hood is fitted to prevent extinguishing by heavy wind or rain. The powder is not affected by moisture; it was as good as dry after having been immersed in a glass of water for some little time. The storing of the powder is not dangerous. Colonel Miklaschewski claims that with his lanterns, signals can be sent a distance of 100 versts, the visibility being increased by the attachment of a mirrored reflector to the lamp.

The powder must be sifted before using. The light being very bright, it is recommended that the signal crew wear smoked glasses or turn their backs to the lantern while signaling. The lantern has been introduced into the army telegraph parks, the cavalry, fortresses and boundary guards.—*Kronstadtski Wiastnik.*

NEW REGULATIONS FOR ENTRY OF ENGLISH NAVAL CADETS.

In pursuance of the decision of the Lords Commissioners of the Admiralty gradually to raise the age for the entry of naval cadets and to shorten to some extent the period of training on board Her Majesty's ship Britannia, the following arrangements will come into force from the 1st of January: Cadets will be entered three times a year instead of twice as hitherto. The appointments will be dated from January 15, May 15, and September 15 in each year. The limits of age on each of these dates in the year 1897 will be: On January 15 and May 15, 13½ to 15 years; on September 15, 13¾ to 15¼ years. For the entry on January 15, 1898, the limits will be 14 to 15½. The limits of ages are raised gradually in order to avoid the undesirable result of cadets newly entered being older than the boys already on the Britannia entered in previous terms. There are to be three terms of about thirteen weeks in each year, to commence and terminate approximately as follows: January 14th to April 14th, May 5th to August 5th, September 16th to December 16th. The period of training on the Britannia will extend over four terms, and the examinations will be held about six weeks before the commencement of each term. The examination for the entries to be made next May and September will be conducted on the same lines as heretofore. A notification will shortly be made public as to subsequent examinations. The period of service as naval cadet afloat is to be eight months, and eight months is to be the maximum time that can be gained on passing out of the Britannia. Arrangements will be made to regulate the seniority of officers now on the Britannia who may be placed at any disadvantage owing to the introduction of these changes.

THE USE OF HOMING PIGEONS IN THE ITALIAN NAVY.

[Translated by Prof. Henri Marion, from the *Revue Maritime.*]

On the 19th of July last, 133 messenger pigeons were liberated from the torpedo-boat J. S. S., which had been designated especially for this service, at a distance of 200 km. from Spezia. The experiment was entirely successful and not a single bird was lost. The total distance was covered in 2 h. 52 m., at an average speed of 60 km. per hour. The same torpedo-boat left again Spezia on the 20th of July with 100 pigeons. After having spent the night at the island of Giametri, these pigeons were liberated at 5 A. M. at a distance of 250 km. from the Spezia loft. At 9.20 the first batch of pigeons reached their destination, and were soon followed by the others, without the loss of a single bird. The average speed made was 57,690 m. per hour.—*Revista Nautica.*

This year, during the Italian naval manœuvres, a special messenger

pigeon service was established, with headquarters on board the Sicilia, flagship of the green fleet, in charge of a lieutenant of engineers of the royal army. Additional cotes were placed on board the Savoia and Umberta, flagships of the yellow fleet, in charge of non-commissioned officers of the army, assisted by some petty officers. There were, all told, 83 pigeons. Four liberations took place, one from the Sicilia at Maddalena, with returns at Rome 15 hours afterwards; another from the Sicilia between Capraia and Vado, and two from the Savoia between the island of Elba and Monte Argentero. This service proved entirely successful.—*Italia Marinera.*

SEARCH LIGHTS IN COAST DEFENSE.

With the object of applying a practical test to the value of search lights as a protection to the entrances to Plymouth Sound, a series of experiments have lately been carried out in which the military forces had the assistance of the torpedo flotilla attached to the port. For some time past the officers connected with the Submarine Mining Establishment of the Royal Engineers at Elphinstone Barracks, Plymouth, have been giving their attention to the distribution of a system of electric lights arranged so as to cover the two approaches to the port of Plymouth and the entrance to the Hamaoze. Previous to these experiments no actual test of the scheme had taken place, and it is hoped to obtain some reliable data as to the efficient working of the scheme, and also whether it is capable of being improved. Owing to the experiments and the arrangements connected therewith being confidential, it is impossible to give any official details; but from observation and other sources, a good deal has been gathered with reference to the experiments, to which considerable importance is attached. The torpedo-boat destroyers Skate, Ferret, Lynx, Opossum, and Sunfish left Devonport about 4.30 P. M. for Plymouth Sound, with the object of returning to the harbor by passing through the areas defended by two of the powerful lights at Picklecombe and Garden Battery under Mount Edgecumbe. The Royal Engineers and Royal Artillery furnished observers at Drake's Island, the Breakwater Fort, Penlee Point, the Redoubt, Maker, Bovisand, Staddon, and some of the other defenses, for the purpose of taking rapid and accurate observations of the movements of the torpedo-boats. The experiments the first night were limited to the western entrance of the sound and harbor, and witnessed from a good point of vantage, they were to all appearances most successful. The lights at Garden Battery commanded the whole of the waters of the sound as far as Drake's Island, and notwithstanding the weather was of the worst description for experiments of this kind, it was possible from the shore to discern small objects afloat. As the destroyers came within range of the defined area they were at first only faintly visible, but as they approached the fierce light which beat upon them from the Garden Battery, they were distinctly seen from stem to stern, and in actual warfare no difficulty would have been experienced in disabling them from one or more of the numerous defenses guarding the western side of the fortress. In continuation of the recent experiments at Plymouth, a trial on a smaller scale was also made at the Needles, when the destroyers Daring and Starfish were employed, with instructions to rush past the Cliff End batteries on the Isle of Wight side and the Hurst Castle fortifications on the mainland, the channel being little

more than half a mile wide. So strong was the glare of the light that for a distance of three or four miles the lookout was practically blinded, and it was only by intimate knowledge of the locality that it was possible to steer the vessels past buoys and other obstructions. The vessels were under orders to first pass the lights and to make a dash on Portsmouth; the gunners in the forts opened fire on the boats the moment they came within observation. The Daring shot past the forts unobserved, and the artillery officer in command has since inquired how it was done, as the Starfish was under fire for three minutes and three-quarters. Now in going out to sea the vessels steamed at 18 knots, four cables apart, and, assuming they adhered to this formation, there would have been no difficulty in detecting them. The Daring extinguished her bow lights, and put on full speed, so that she passed the forts before she was expected, and, having no lights, eluded suspicion. The experiment, small in itself, is not without importance. If the raiding boat is only to make a rush at the moment she is expected, there is small chance of her success; but in this instance, by putting out her lights and anticipating expectation by a few minutes, the Daring evaded the watch. It is uncomfortable to think that the Daring did precisely what an enemy would do and that she was successful. —*Journal Royal United Service Institution.*

TESTS OF ARMOR AND SHELL.

United States.

A test of Carnegie armor was made at Indian Head grounds on March 18. A plate, tapering from 16½ inches at the top to 9½ inches at the bottom, representing a group of side armor of 600 tons for the battleships Kearsarge and Kentucky, safely resisted the impacts of two 10-inch shells delivered with high velocities, and this without cracking or permitting penetration of the projectiles to any appreciable depth. Upon the showing thus made, Capt. W. T. Sampson recommended to the Secretary that the group be accepted. The plate was supported by an oak backing 36 inches in thickness. Two projectiles manufactured by the Wheeler-Sterling Company were employed. The first projectile, weighing 500 pounds, struck the plate at a point three and one-half calibers from the bottom and seven calibers from the end, the thickness of the metal being 12 1-10 inches. The point of the projectile penetrated three inches, and then broke, the base falling in fragments at the foot of the target. The velocity employed was 1340 feet per second. The second shell also weighed 500 pounds, and it was fired for penetration at a high velocity. The point of impact was located three and a half calibers from the top of the plate and an equal distance from the side. The plate at this point was 13 8-10 inches thick. The shell penetrated seven inches and then broke up. The metal around the point of impact was slightly dished, but otherwise the plate showed no signs of damage.

The contest for supremacy between armor and shell is always in progress. The Carnegie Steel Company has just completed a plate which it believes will eclipse anything it has yet turned out in point of resistance. The plate is 12 inches in thickness. It is made of nickel steel, but contains a higher percentage of the former metal than has yet been used in the

manufacture of service armor, and has been treated by the Harvey process with such changes in the treatment as the new conditions require. A plate of this kind was made about a year ago and was tested. While it broke into three pieces when a shell, given a velocity of 2000 feet per second, struck it, it demonstrated good resistive qualities, and the Carnegie Company determined to manufacture another plate which should be equally resistive but tougher. The firm believes that it has obtained this combination in the plate just finished. In the proposed test a 12-inch gun will be used and the velocity will be about 2000 feet per second, and higher if the results of the first shot demonstrate that another can be successfully fired.—*Army and Navy Journal.*

A test to-day, March 29, of a port plate at the Indian Head proving grounds indicated that there must be a change in the shape of plates of this character, otherwise their use may become a source of serious danger to vessels in time of war.

A Carpenter projectile, six inches in caliber, was fired at the wing of the re-entrant portion of the plate. The angle of impact was forty-five degrees. The wing was broken off through the point of impact and hurled backward with great velocity, being found about eighty feet in the rear of the target. Had the plate been fitted to the side of a vessel, the fragment, weighing about one thousand pounds, would have been driven clear across the ship and would undoubtedly have caused considerable damage.

The plate tested was five and one-half inches in thickness and was manufactured by the Carnegie Company. It represented a group designed for the battle-ships Kearsarge and Kentucky. It was fitted to a backing of three inches of oak planking and two ½-inch skin plates. A 3-inch plate, to represent a gun shield, was placed alongside the wing of the port plate. The shell was smashed into a myriad of fragments and spattered the experimental shield plate, none, however, getting through. In this latter sense the trial was satisfactory.

The test of the port plate was preceded by a trial of two plates representing the protective deck plates for the Kearsarge and Kentucky. The plates were two and three-quarters inches thick and were fired at with a 6-inch gun. The line of fire made an angle of seven degrees with the surface of the plates—the probable angle at which the protective deck could be struck. The first shell fired—a Carpenter projectile—was broken into fragments. The plate was dished, but was neither penetrated nor cracked.—*New York Herald.*

England.

The *Admiralty and Horse Guards Gazette* reports that the trials of the new armor plate intended for the Canopus have yielded some remarkable results. It was of Harveyized nickel steel, 6 inches in thickness, and after four Holtzer projectiles of forged steel, 6 inches in diameter, weighing 100 pounds each, and striking the plate with an energy of 2665 tons, had been discharged against it, the plate was still unperforated. The *Gazette* says: "On the face of it, this is a good performance, but it is asserted that in the United States, some months ago, a 6-inch Johnson shot, with a soft steel cap, dealt very roughly with a 10-inch plate of similar quality to that now under consideration. According to the same account, an 8-inch Holtzer shot broke into pieces when fired against this

marvelous plate. If, too, we are content to rely upon the fact that we must accept accounts from the other side of the Atlantic with many grains of salt, it may be as well to remember that the Russians have made experiments which tend in the same direction. Our own trials of the soft steel cap have not been satisfactory, but other powers appear to have overcome the difficulties with which we have met. Krupp, indeed, has an astonishing record, if all the surrounding circumstances are honestly told."

At Shoeburyness, on February 28th last, a remarkable result was achieved by a Firth steel projectile fired from the 12-in. wire gun, with a striking velocity of 2300 foot seconds, at a target consisting of an 8-in. compound plate, supported by 6-in. wrought iron plate on 8 feet of oak backing with 3 inches of iron behind it. The striking energy of this shot is 31,160 foot tons, and its perforation on Tresider's system is 35.05 inches of iron. The front armor, on the regular system of calculation, is equivalent to about 28 inches of wrought iron. The projectile passed not only through this and also the backing and 3-in. skin, if it may be so called, but also passed on, entering a bank of clay and sand 30 yards in rear of the target to such a depth that it has not even yet been recovered.

The target was, of course, overmatched, supposing the projectile capable of performing the task imposed on it, but it may be seen that a projectile which will thus stand up and deliver the great energy embodied in it must be a very execellent one; and its recovery, for which we have hitherto waited, is desirable, in order to see its condition, which we should expect to be very good. We consider thick compound armor plates liable to uncertainty in their quality, but we are informed that this one appeared to be a good sample, and that the officials had no fault to find with it, and were highly pleased with the success of the shot, which the makers understood them to pronounce superior to any hitherto fired. This result is specially welcome, because high-class armor-piercing projectiles are very difficult to make, and greatly needed at the present time.

Russia.

It is reported that in last November a remarkable trial of armor took place at Ochta, near St. Petersburg. An 8-in. gun, 45 calibers long, is said to have driven a shot through a Krupp 10-in. steel plate with a hardened face. The striking velocity is given as 2850 foot seconds, and it is stated that the projectile emerged at the back with a velocity of 700 foot seconds. This is in all respects a valuable experiment. The very high velocity, the hard-faced plate, and the register of the shot after perforation are the very elements to be desired. The projectile must have been an admirable one if it held together intact. We do not know its weight. Russian 8-in. armor-piercing projectiles exist weighing 192.3 lbs., and also 172 lbs. Both are light for this caliber; the British 8-in. shot weighs 210 lbs. This makes the velocity more easy of achievement. Nevertheless it is very high for plate firing. With the heavier shot, the striking energy and perforation through iron would be 10,820 foot tons and 27.3-in., and with the lighter 9685 foot tons and 26.7-in. The shot emerged with an energy, on the supposition of the heavier weight of shot, of 653 foot tons, and of the lighter, of 584 foot tons. From this it follows that either 10,167, or else 9101 foot tons energy was expended in perforating the plate. The projectile in this case exerted a power of perforation equal to 27.0 inches, or 25.5 inches of iron. This means that the figure of the Krupp

10-in. plate was 2.7 inches or 2.55 inches; that is, it represented a thickness of wrought iron bearing this proportion to it in thickness, which argues a very excellent plate. Altogether we could wish that we had more complete data connected with this trial. We need scarcely add that on service such a plate might be safely depended on to defeat the gun. A projectile quickly loses some of its velocity, and so close a range, so direct a blow, and so excellent a shot would form a combination of favorable circumstances that would hardly occur on service.—*Engineer.*

SHIPS OF WAR.

General.

The war-ships, exclusive of torpedo-boats, launched during the year 1896 for the various navies, and their tonnage, I. H. P., and estimated speed were as follows:

Great Britain.—First-class battle-ships: Mars, Caesar, Illustrious, and Hannibal, all of 14,900 tons, 12,000 I. H. P., and 17 knots speed. First-class cruiser: Diadem, 11,000 tons, 20,000 I. H. P., and 20 knots speed. Second-class cruisers: Arrogant, Furious, and Gladiator, of 5750 tons, 10,000 I. H. P., 19 knots speed; Dido, Doris, and Isis, of 5600 tons, 9600 I. H. P., and 19.5 knots speed. Third-class cruisers: Pelorus and Pactolus, of 2135 tons, 7000 I. H. P., and 20 knots speed. Torpedo-boat destroyers: Avon, Bat, Brazen, Chamois, Crane, Desperate, Earnest, Electra, Vulture, and Whiting, of 300 tons, 6000 I. H. P., and 30 knots speed.

Argentine Republic.—Torpedo-boat destroyers: Santa Fe, Corrientes, Missiones, and Entre Rios, of 250 tons, 4000 I. H. P., and 30 knots speed.

Austria-Hungary.—Coast-defense battle-ship: Buda-Pest, of 5550 tons, 8500 I. H. P., and 17 knots speed.

Brazil.—Second-class cruiser: Barrozo, of 3500 tons, 7500 I. H. P., and 20 knots speed. Torpedo-cruisers: Caramuru and Tupy, both of 1030 tons, 6000 I. H. P., and 23 knots speed.

Chili.—First-class armored cruiser: Esmeralda, of 7000 tons, 18,000 I. H. P., and 23 knots speed. Second-class cruiser: Ministero Zenteno, of 3450 tons, 7000 I. H. P., and 20 knots speed. First-class torpedo-gunboat: Almirante Simpson, of 800 tons, 4500 I. H. P., and 21 knots speed. Torpedo-boat destroyers: Capitan Munez Gamero, Capitan Orella, Teniente Serrano, and Guardia Marina Riqueime, of 300 tons, 6000 I. H. P., and 30 knots speed.

Denmark.—Coast-defense monitor: Skjold, of 2160 tons, 2200 I. H. P., and 13 knots speed.

France.—First-class battle-ships: Amiral Bouvet, of 12,200 tons, 14,000 I. H. P., and 17 knots speed; Saint Louis and Gaulois, 11,275 tons, 14,500 I. H. P., and 18 knots speed. First-class cruiser: D'Entrecasteaux, of 8114 tons, 13,500 I. H. P., and 19 knots speed. Second-class cruisers: Catinat, Cassard, and D'Assas, of 3952 tons, 9000 I. H. P., and 20 knots speed.

Germany.—First-class battle-ship: Kaiser Friedrich III., of 11,000 tons, 13,000 I. H. P., and 18 knots speed.

Italy.—First-class armored cruiser: Carlo Alberto, of 6500 tons, 13,000 I. H. P., and 20 knots speed.

Japan.—First-class battle-ships: Fuji-Yama and Yashima, of 12,600 tons, 13,690 I. H. P., and 18 knots speed.

THE NETHERLANDS.—Second-class cruisers: Friesland and Holland, 3900 tons, 9250 I. H. P., and 20 knots speed. Station gunboat: Mataram, of 810 tons, 1100 I. H. P., and 13 knots speed.

NORWAY.—Torpedo-gunboat: Valkyrien, of 380 tons, 3300 I. H. P., and 26 knots speed.

PORTUGAL.—Third-class cruiser: Adamastor, of 1750 tons, 3000 I. H. P., and 18 knots speed.

RUSSIA.—Second-class battle-ship: Rotislav, of 8800 tons, 8500 I. H. P., and 16 knots speed. Coast-defense battle-ship: Admiral General Apraxine, of 4126 tons, 5000 I. H. P., and 16 knots speed. First-class armored cruiser: Rossia, of 12,200 tons, 17,000 I. H. P., and 19 knots speed. Second-class cruiser: Svetlana, 3711 tons, 8500 I. H. P., and 20 knots speed. First-class gunboat: Giljak, of 960 tons, 1000 I. H. P., and 12 knots speed.

SPAIN.—First-class armored cruisers: Princesa de Asturias, of 7000 tons, 15,000 I. H. P., and 20 knots speed; Christobal Colon, of 6840 tons, 14,000 I. H. P., and 20 knots speed. First-class gun vessel: Dona Maria de Molina, of 823 tons, 4600 I. H. P., and 19 knots speed. Torpedo-boat destroyers: Furor and Terror, of 400 tons, 6000 I. H. P., and 30 knots speed.

SWEDEN.—Coast-defense battle-ship: Oden, of 3300 tons, 3700 I. H. P., and 16 knots speed.

UNITED STATES.—First-class battle-ship: Iowa, of 11,410 tons, 10,000 I. H. P., and 16 knots speed. First-class gunboats: Helena, Vicksburg, and Newport, of 1392 tons, 1600 I. H. P., and 13 knots speed.—*Journal Royal United Service Institution.*

[UNITED STATES.]

TORPEDO BOAT NO. 5.

Torpedo-boat No. 5, the third and last of the torpedo-boats under construction for the Navy by the Columbian Iron Works, of Baltimore, was launched at the company's yard, January 6th. Her total cost will be $97,500. She is constructed of steel of the regular Navy requirements, is 160 feet long and 16 feet broad, with a displacement of 142 tons. Her armament will consist of three 18-inch Whitehead torpedo tubes on her upper deck, trained to fire at any angle, and three 1-pounder rapid-fire guns. She is estimated to be capable of a speed of 24½ knots per hour. Her machinery comprises two triple expansion, four cylinder engines, one on each side shaft, in water-tight compartments. The indicated horse-power is 2000. Her coal capacity will be forty-four tons. Her crew will consist of twenty-four men, with four officers.

TORPEDO BOAT NO. 6.

Torpedo-boat No. 6 on its trial trip maintained an average speed of 28.74 knots per hour for a distance of 60 miles. This is equal to 33.1 statute miles per hour, a speed which not a great many years ago would have been equal to the average all-day speed of our passenger trains.

The course was 12 miles long and it was covered in five successive runs. On the first run she crossed the line carrying a steam pressure at the engines of close upon 220 lbs. to the square inch, and her engines were running at the high speed of 405 revolutions per minute. There were

two excellent features that were immediately apparent to those on board, the first being the absence of any banking up of a heavy bow wave (the commotion which our readers will notice in the cut being merely the surface foam); the second good feature was the absence of that extreme vibration which is usually felt in a torpedo-boat when she is pushed to her full speed. The quiet way in which she cuts through the water will be an invaluable feature during a night attack. It will increase the chances of stealing up to the enemy unobserved, and the silence and smoothness with which her engines run at high speed will also be greatly in her favor. It was remarked by the officials on board that the vibration was not sufficient to interfere with writing legibly in any part of the vessel. Any one who has been aboard one of the 30-knot torpedo-boat destroyers on a trial trip will appreciate what this statement means. It is well known that torpedo-boat service is about the most trying that exists in any navy, and much of its discomfort arises from the perpetual jarring to which the crew are exposed. The vibration is due to the fact that such enormous horse-power is crowded into a little vessel of extremely light construction.

It is a difficult problem to place in a boat only 175 feet long and 17½ feet wide a set of 4000 twin engines that shall drive the propellers at over 400 revolutions per minute, and do it without shaking the little craft from stem to stern. The lightness of the construction of No. 6 may be judged from the fact that there is not a plate in her hull that is more than a quarter of an inch thick.

The first heat of twelve knots was run off in 24 m. 52 s., at a speed of 28.97 knots. The second was made in 24 m. 57 s., corresponding to 28.85 knots. The third trial resulted in a speed of 28.78 knots, and the fourth showed a speed of 28.87 knots. The average for the 48 knots was, therefore, 28.87 knots. The last run had scarcely commenced when one of the blowers broke down, a mishap which caused a falling off of the steam pressure and brought down the speed to 28.23 knots, which was 0.73 knot above the contract requirement. The average speed of the whole 60 knots was 1¼ knots above the contract speed of 27½ knots.

The manœuvring powers of the new boat are excellent, the turns at the end of each run being made in a very small circle, and although the helm was "hard over," the amount of "heel" was insignificant.

She carries three torpedo launching carriages, one forward on the port side, one amidships on the starboard side, and a third at the stern on the center line. She is also armed with three 1-pounder rapid-fire guns. The full complement of the little ship is four officers and twenty-four men.

The remarkable success of this little craft will give increasing interest to the trials of the three 30-knot boats which are now building for the Navy, one on the Pacific coast and two on the Atlantic. If they show as great an advance on contract requirements as No. 6 has done, it is possible that the record for torpedo-boat speed may remain for a few months on this side of the water, or until the new 32-knot destroyers for the English Navy shall have had their trials.—*Scientific American.*

Trial Trip of the Helena.

With a light westerly breeze and scarcely a ripple on the waters of Long Island Sound, the gunboat Helena speeded across a twenty-seven mile course to-day at a rate of 15.81 knots an hour, exceeding the contract speed of thirteen knots, required of the vessel, to such an extent that she earned a bonus of about $56,000, or $16,000 more than her sister ship, the Wilmington, which had her official trial last Saturday.

Both the Trial Board and the builders' representatives speak in glowing terms of the two gunboats, especially of the Helena, which steamed over the course and back to-day with machinery working to perfection, and vibration that was scarcely perceptible from her deck.

The boat weighed anchor at half-past six o'clock this morning, and with a parting wish for good luck from the crew of the Wilmington, close by in the stream, glided out of the harbor and was ready for the signal to fly past the torpedo-boat Porter, two hours later, at the starting point of the course. In the fireroom everything was ready for the forced draught, doors were closed air-tight and water-tight, and the blower was revolving at a rate of speed that sucked in the outer air in great volumes.

The ship met the first of the ebb tide at the start and had it against her all the way. But it was not strong, and on the run home she had its favoring impulse. The men in the fireroom were sweltering during the running of the boat under forced draught, but they endured it bravely. They were liberally furnished with ginger ale.

The way the ship sped along on the first reach from the Porter, about three and a half miles from Horton's Point, made it evident that she was making fast time. On the outward run to Old Field Point the maximum revolutions of the screw were 282 and the minimum 276, the average being 279. The average in knots was 15.34. The run back was made as soon as the ship had made a turn or two and run long enough to permit the indicator cards to be run out.

The total elapsed time for the first half was 1 hour 45 minutes 37 seconds and for the last half 1 hour 39 minutes and 25 seconds, making the total elapsed time for the full run of twenty-seven knots 3 hours 25 minutes and 2 seconds.

When the run was ended the Helena kept going until she had run out her four hours and made several circles. The coal consumption on her four hours' run was seven tons.

The Wilmington sailed for Newport News about five o'clock this afternoon, and the Helena will follow to-morrow.—*New York Herald.*

[England.]

The Isis.

Her Majesty's second-class cruiser Isis has undergone a very satisfactory thirty hours' coal-consumption trial at both natural and forced draughts. According to the *Naval and Military Record*, with natural draught, her engines indicated 8208 horse-power, with a mean speed of 19.8 knots per hour; while at her forced-draught trial her engines averaged 9840 horse-power, with a speed of 21.1 knots per hour. The specifications provided for 8000 horse-power with natural, and 9600 with forced draught. She has been built by the London and Glasgow Shipbuilding Company.

The Niobe.

H. M. S. Niobe was successfully launched on February 20 from the yard of the Naval Construction and Armament Co., Barrow-in-Furness. The vessel is one of eight, six of which are being built by contract, four on the Clyde and two at Barrow, while the other two are being constructed at Pembroke Dockyard. The Niobe is 435 ft. in length between perpendiculars, but the overhanging stern and the projecting ram make the

length over all 463 ft. The breadth over sheathing is 69 ft., and her moulded depth to the upper deck 39 ft. 9 in. The mean load draught of the vessel is 25 ft. 3 in., at which draught the displacement is 11,070 tons. The hull of the vessel is constructed of Siemens-Martin steel, with a 4-in. sheathing of wood to 9 ft. above the load water-line, the heavy external framing of the ends, stem and sternpost and propeller brackets, and the rudder frame being, as is usual in sheathed vessels, phosphor-bronze castings. The rudder is of the balanced type, and the stem curved outwards under the water so as to form a formidable ram. Two long bilge keels 3 ft. deep are also fitted to prevent rolling. Amidships the vessel's bottom is constructed on the cellular principle, the inner skin being carried to the protective deck. The double bottom, or the space between the two skins, is minutely subdivided into water-tight compartments which are partly used for the carrying of water, and afford security against sinking should the outer skin be pierced. By water-tight bulkheads and water-tight flats the vessel is throughout closely subdivided.

The protection consists of an armored deck of steel plating 4 in. thick at the crown, and extends the whole length of the vessel. It is arched in section, rising from 6 ft. under the water-line at the side of the vessel to 4 ft. above the water-line at the crown of the arch. Under the deck, which is raised for the purpose in way of the engines, are placed the propelling machinery, the steering engines and gear, the capstan engines, the air-compressing machinery, and all the magazines, shell-rooms and torpedo-rooms. The coal bunkers, which have a capacity for over 2000 tons of coal, are arranged along the sides of the boiler-rooms and along the sides of the vessel on the protective deck above the engines and boilers, thus affording most satisfactory coal protection to the machinery of the vessel. The armament of the vessel, as will be seen from the following, is of a most powerful description. There are sixteen 6-in. quick-firing guns, twelve 12-pounder quick-firing guns, three 3-pounder quick-firing guns, two 12-pounder boat and field guns, and eight .45-in. Maxim machine guns. The Niobe is supplied with three torpedo-tubes, one of them firing right aft above the water-line, while two broadside under-water tubes are placed under the protective deck in a special compartment forward. The 6-in. guns and 12-pounder guns will be supplied with ammunition through armored tubes extending from the protective deck to the deck on which the guns are worked. An ammunition passage is arranged on each side of the ship below the protective deck and extending for the whole length of machinery space. The passage is completely protected by coal on top, sides and bottom, so that the ammunition need never be exposed to fire in its course from the magazines to the guns. The total complement of the vessel, including the admiral's staff, will be 718 men, for whose comfort every provision is made.

The Jupiter.

H. M. battle-ship Jupiter, built by the Clydebank Engineering and Shipbuilding Company, Limited, completed her official trials at Chatham on March 5. On the 2nd the vessel went out for her four hours' full-power forced-draught trial, during which time a steam pressure of 150 lbs. was easily maintained with an air pressure of .62 in. of water. The vacuum in condensers was 26.6 in. The port engine ran at 101.7 revolutions per minute and developed 6127 indicated horse-power. The starboard engine, running at 102.4 revolutions per minute, developed 6348 indicated horse-

power, the collective indicated horse-power being 12,475, which gave a mean speed for the four hours of 18.4 knots. The designed power was 12,000 indicated horse-power, and the speed 17½ knots.

On the following day the eight hours' natural draught trial was commenced, and this trial was also satisfactory, as with .2 in. air pressure a mean steam pressure of 148 lbs. was kept up, and the engines developed a collective indicated horse-power of 10,248. The mean speed on this trial was 15.8 knots; but record was only taken by log, which is often far from reliable.

On the next day, the 4th, the vessel started the 30 hours' coal consumption; on this trial, with a mean collective indicated horse-power of 6193, the coal consumed per indicated horse-power per hour amounted to 1.51 lbs. The mean steam pressure during this trial was 146 lbs., the vacuum 26.6 in. The starboard engine, running at 81.5 revolutions, developed 3116 indicated horse-power, and the port engine, running at 81.1 revolutions, developed 3077 indicated horse-power. The Jupiter is of the Majestic type.

The Pegasus.

The Palmers Shipbuilding Company, Newcastle-on-Tyne, launched, on March 4, two vessels, one a third-class cruiser named Pegasus, and one of several 30-knot destroyers, the Flying Fish. The Pegasus belongs to the Pelorus class.

The principal dimensions are as follows: Length between perpendiculars, 300 ft.; breadth, extreme, 36 ft. 6 in.; depth, moulded, 21 ft. 2 in.; displacement, on a mean draught of 13 ft. 6 in., 2135 tons; indicated horse-power, 7000; speed, 20 knots.

The armament consists of eight 4-in. quick-firing guns, eight 3-pounder quick-firing guns, three .45-in. Maxim guns, and two 14-in. torpedo-tubes. Two of the 4-in. guns are placed on the forecastle deck, one on the port side, and one on the starboard side; two on the poop deck, one on each side; and four on the upper deck between the poop and the forecastle, two on each broadside.

Two of the 3-pounders are placed forward on the upper deck, one on each side of the bow; two are placed aft on the upper deck, one on each side of the stern; and four on the upper deck between the poop and forecastle, two on each broadside.

Two of the .45-in. Maxim guns are placed on the hammock berthing amidships, and one on the forecastle deck. The torpedo-tubes are on the upper deck, one on each broadside.

The Flying Fish.

The Flying Fish is the sixth of eight vessels of the same type which Palmers' Company are building for Her Majesty's Government. Her dimensions are: Length, 215 ft.; breadth, 20 ft. 9 in., and the displacement is about 300 tons. Her armament consists of one 12-pounder quick-firing gun forward on the conning tower, two 6-pounder quick-firing guns on each side, and one 6-pounder on a platform aft. There are also two revolving torpedo-tubes on deck arranged to fire on either side. The builders have guaranteed a speed of 30 knots, and as a matter of fact the sister ship Star maintained a speed of 31 knots for three hours, proving herself the fastest vessel afloat; the machinery, which has been designed by the builders, consists of two sets of triple-expansion engines, steam being

supplied by four of Reed's water-tube boilers. The Whiting, another of the destroyers built by Palmers' Company, has run a number of times over the measured mile at an average speed of 30.2 knots, and was kept running for three hours at an average speed of 30.1 knots.

It has been decided to arm the new second-class cruisers Hermes, Highflyer, and Hyacinth, which are now being built, with more powerful guns than was intended when the vessels were originally designed. It was at first arranged that they should have five 6-in., six 4.7-in., and 16 smaller quick-firing guns. Under the new order they will each have eleven 6-in., nine 12-pounders, and six 3-pounder quick-firing guns.

[France.]

Changes in Dockyard Organization.

During the discussion on the naval estimates in the Chamber, Vice-Admiral Besnard, Minister of Marine, announced that it had been decided to effect important changes in dockyard organization, which would comprise the complete separation of the supervision of ships already constructed from those building.

The new regulations have now been settled, but before putting them into practice they will be finally submitted to the Committee of Inspectors-General.

The *Temps* gives the following account of the new proposals:

The main principle is to be continuity of command of the ship from the day she leaves the hands of the constructor, the naval officer then appointed to the command retaining the same ship till promoted or retired. It will be his duty to be responsible for the armament, mobilization and repairs of the ship, and he alone will be the judge of any alterations to be introduced, as the ship will never afterwards be placed in the hands of the Constructive Department.

The new duties of the naval officer will necessitate the creation of a new department in the dockyards, that of "Direction de la flotte," at the head of which in each port will be placed a rear-admiral as inspector-general.

The "Service de la flotte" will have its own storehouses and will be in a position to maintain all the ships in its charge in an effective condition. The Constructive Department will only intervene when the repairs are such as to necessitate the assistance of the full dockyard staff; in such a case the "Service de la flotte" will act towards the Constructive Department in the same way as if the work was being performed by private contract; it will superintend and have entire control of the work performed, and all materials supplied and any changes required in the working hours of the workmen employed will have to receive its sanction, so that it will not be possible in the future to charge other expenses to the repairs of ships with a view of hiding mistakes made in estimates for new constructions—a practice which has often been complained of and condemned by members of the Chamber.

The "Service de la flotte" will be charged with the duty of preparing ships for mobilization, and for this purpose will possess special storehouses to contain all consumable stores to be issued to the ships on commissioning, and also all non-consumable stores belonging to completed ships. In principle, each ship belonging to a port will have its own separate store, but it may be found possible to avoid this expense and make each ship its own storehouse.

[GERMANY.]

RESTRICTIONS IN USE OF WOOD FOR INTERIOR FITTINGS OF SHIPS.

As the result of the experiences drawn from the battle of the Yalu, the use of wood has been much restricted in the new German ships. According to Herr A. Dietrich, Constructor-in-Chief of the Imperial Navy:

"In the outfit and construction of the new German ships wood is used only for a few minor points. Wooden deck planks are no longer laid; steel deck plating is covered with linoleum, sometimes over a layer of cork. In the crews' quarters the sides of the ships are not ceiled; in the officers' rooms the ceiling is made of steel plates 1½ millimetres thick and lined with cork. For cabin bulkheads the steel is covered with thin woollen cloth, and with cork lining underneath where it is desirable to exclude sound or lower the temperature. Where heat is radiated from engine or funnel casings, cork lining is resorted to. All wood is removed from the ammunition rooms, save the racks for shells and powder charges, which are still made of wood. For all ladders and steps steel is used. The handrails on the conning bridges are no longer of wood, but of some other material which will not burn or splinter, and which is more agreeable to the touch of the hand than steel or brass. Chart-houses and captains' rooms on bridges are entirely made of steel and fitted out with non-combustible materials. Since all such changes will be a little exaggerated, it seemed to be advisable to abandon wood for the interior fittings, and especially for the furniture, and to resort to fireproof material which will not splinter. Many things were tried; furniture was made of steel and aluminum, lined with cork and covered with linoleum or canvas; but it was not equal to wood furniture. Only the bedsteads are constructed of iron, steel or brass. The insignificant quantity of wood in the few pieces of furniture when ignited is not a dangerous source of smoke, but rather it is the outfit of the state-rooms, the mattresses, blankets, clothing, books, etc. However, for the present, wood cannot be abandoned entirely. Top signal masts, flag poles, etc., will be made of steel, but there one cannot save weight. The fighting capacity of the ships is without doubt increased through these innovations, since the ship is less apt to burn, the effects of splinters are restricted, and considerable weight is saved, which is available for ordnance and armor."

It may also be mentioned that in German ships-of-war the protective under-water deck is never cut through either for ventilation or coaling purposes.

[SPAIN.]

TORPEDO-BOAT DESTROYERS FUROR AND TERROR.

The torpedo-boat destroyers Furor and Terror, designed and built by Messrs. James and George Thomson, Limited, Clydebank, to the order of the Spanish Government, have now completed their trials, and have arrived in Spain. Although similar in general design to the destroyers of the British Navy, there are several departures in detail, and the vessels are in some respects more nearly akin to the torpedo gunboats. For example, they are fitted with teak upper decks in addition to a complete steel deck; double awnings for the whole length of the vessel, with side curtains hanging to the water's edge, electric lighting throughout, and a number of electrical ventilating fans for insuring a supply of fresh air to

the officers' and crew's quarters; so that the vessels will be much more habitable than an ordinary torpedo-boat destroyer when serving in the tropical or semi-tropical climates for which they are intended. The contract provided that the mean speed should be determined by four runs on the measured mile, and by a further trial of two hours' duration, during which the speed should not be less than 28 knots. It was further stipulated that a load of 75 tons should be carried or trials, which is more than twice the load required in the case of vessels of a similar type built for the British Navy.

The vessels have a length of 220 ft., breadth 22 ft., and have a moulded depth of 13 ft. The loaded displacement is 380 tons. The armament consists of two 14-pounder quick-firing guns, the one mounted forward on top of the conning tower and the other aft; two 6-pounder guns of the same type mounted on the broadside, and two 37-millimetre automatic quick-firing guns, one on the starboard and the other on the port bow. All these guns have been supplied by the Maxim-Nordenfeldt Guns and Ammunition Company, Limited, and are of the latest and most improved pattern. The vessels are also equipped with two torpedo-tubes, 14 in. in diameter, mounted on the upper deck, so as to fire off either side of the ship. The torpedo-tubes are on the Schwartzkopff system. Four torpedoes are carried, and there is, of course, a complete installation of air-compressing machinery for charging them, the engines and pumps being in the engine-room.

After some preliminary trials, the Furor successfully passed her official forced-draught trial on October 30. The mean speed of four runs on the measured mile exceeded the contract by about a quarter of a knot, and the revolutions were maintained without difficulty for the two hours' trial. The Terror, after a single preliminary trial, completed her natural-draught trial, and, at the next succeeding trial, successfully completed her official forced-draught trial. The natural-draught trials were of the same duration as the forced-draught trials, and it was provided by the contract that a speed of 21½ knots be maintained with the air pressure in the stokeholds not exceeding ¾ in. of water. It was found that this speed could be maintained with very great ease; indeed, the stipulated speed was exceeded by about a knot.

After the speed trials, the firing trials of the guns were carried out to the entire satisfaction of the inspecting officers. The terribly destructive nature of the fire, especially from the automatic guns, was very apparent, a perfect hail of projectiles of 37 millimetres, or about 1½ in. in diameter, being delivered by these guns, and continued so long as the person firing the gun kept his finger pressed on the trigger, the whole of the operations of loading and firing being automatically performed by the energy of the recoil.

On Saturday, February 6, the Clydebank Engineering and Shipbuilding Company (Limited), launched from their yard at Clydebank a twin-screw torpedo-boat destroyer built to the order of the Spanish Government. The vessel, which was named the Audaz, is of greater tonnage than the Furor and Terror, lately delivered from the same yard, and will carry the same armament, but she will be two knots faster.

The firm of J. and G. Thomson, Clydebank, has received contracts from the Spanish Government for the construction of sixteen torpedo-boat destroyers of the Furor and Terror type.

New Spanish Floating Dock.

The well-known shipbuilders on the Tyne, Messrs. Robert Stephenson & Company, Limited, have definitely concluded negotiations with the Spanish Government for the building of a floating dock, to be located at the port of Olongapo, Philippine Islands. The dock, which will be the largest yet constructed anywhere, is of the following dimensions: Length, 450 ft.; width, over pontoons, 117 ft.; depth to the top of side walls or girders, 38 ft. 6 in. The dock, when completed, will rest on a series of six pontoons, each of which will be between 13 ft. and 14 ft. deep. These latter will be constructed of iron; while the side girders, which constitute the walls of the dock, will be of steel. The arrangement of the pontoons in the design is such that in the event of any of them getting damaged and requiring to be repaired, it can be temporarily detached from the rest of the structure and floated on to the dock itself. The dock is intended to lift vessels up to 12,000 tons, and will have an equipment of four powerful pumping engines, capable of pumping 12,000 tons of water in two hours. Though capable of taking vessels 500 ft. long, the weight of which will be pretty evenly distributed over the whole of the structure, it is specially designed to lift vessels of the maximum weight—12,000 tons—the length of which may not exceed 300 ft. In the latter case it is evident the pressure will be concentrated in a smaller area, and will, therefore, test more severely the stability of the whole. To give to the structure the necessary strength for resisting central pressure or distributed pressure with equal certainty, special care has had to be taken in the designing. For convenience of shipment the dock is to be built in sections, which in due course will be sent out to Olongapo, where the structure will be finally put together and completed.—*London Engineer.*

[Portugal.]

New Cruisers.

The Portuguese Government has placed contracts with La Société des Forges et Chantiers de la Méditerranée for two cruisers of 1800 tons displacement, to be built in Havre. Dimensions to be as follows: Length, 246 feet; beam, 35 feet; draught, 14 feet; horse-power, 2650. The armament comprises two 15-cm., four 12-cm., and eight 4.7-cm. Canet guns, all on Canet mounts with shields. The torpedo armament consists of a submerged bow tube. Speed to be 15 knots.

[Norway.]

Harald Haarfagre.

On January 4 was launched from the Elswick yard on the Tyne the Harald Haarfagre, a new armor-clad for this government. She is the first important armored ship built for the Norwegian Navy, and her dimensions are as follows: Length, 280 feet; beam, 48 feet 6 inches; and with a mean draught of 16 feet 6 inches, her displacement will be 3500 tons. Protection is afforded by an 8-inch armor water-line belt and a 2-inch armored deck. The armament will consist of two 21-cm. (8-in.) guns, mounted in hooded turrets protected by 8-in. armor, one forward and one aft, four 6-in., six 12-pounder, and six 1½-pounder guns, all Q. F., with two discharges for 18-in. torpedoes. A sister ship is also under construction at the same yard.

Valkyrien.

The torpedo-boat destroyer Valkyrien, completed last year by the Schichau firm at Elbing for the Government, maintained a mean speed of 23.2 knots during her official trials, the engines making 240 revolutions and developing 3300 I. H. P., the boilers being Thornycrofts. She is a vessel 188 feet 6 inches long, 23 feet beam, and with a draught of 7 feet has a displacement of 380 tons. The armament consists of two tubes on deck for 18-inch torpedoes, one amidships and one aft, with one 6-pounder and one 1-pounder Q. F. guns. The cost of the Valkyrien was defrayed by subscriptions collected by the Patriotic Ladies' League.

Delfin, Hai, and Hval.

Three first-class torpedo-boats, the Delfin, Hai, and Hval, have just been completed and delivered by the Schichau firm of Elbing; they are 120 feet long, are fitted with Thornycroft's boilers, and have a mean speed of 23 knots. They carry two 18-inch torpedo-tubes on deck and two 1-pounder Q. F. guns.

[Sweden.]

Oden.

The Oden, one of the new type of improved Svea battle-ships, is now almost ready for her trials, while two others, the Thor and Njord, are nearly ready for launching. The Thor is being constructed at the yard of the Bergsunds Maschinenfabrik in Stockholm, and the Njord at the yard of the Lindholmens Fabrik in Gothenburg; the engines are being constructed by the Motala firm; both ships are to be completed by the end of 1898. The dimensions of these ships are as follows: Length, 277 feet 4 inches; beam, 47 feet 10 inches; and with a maximum draught of 16 feet 6 inches they will have a displacement of 3400 tons. The engines are to develop 3700 I. H. P., giving a speed of 16 knots. There is a 12-inch armor water-line belt for about two-thirds of the length of the ship, and a 4-inch casemate amidships for six 15-cm. (5.9-inch) Q. F. guns; the principal armament consists of two 24-cm. (9.4-inch) guns, one forward and one aft in hooded barbettes protected by 12-inch armor, and there are also ten 6-pounder Q. F. guns, four machine guns, and an under-water bow torpedo-tube. The armor for all three ships is being made by the French firm of Schneider at Creusot. The heavy guns for the Oden and Thor will be made by the French firm of Canet, while those for the Njord will come from the Swedish manufactory at Bofors. It is stated that the Bofors establishment is to be taken over by M. Nobel, of Paris, and will be greatly enlarged.

Jarnan and Edjern.

The two torpedo cruisers Jarnan and Edjern, now nearly ready for launching, are of a similar type to the Ornen, their dimensions being as follows: Length, 220 feet; beam, 27 feet 6 inches; a displacement of 670 tons; with engines developing 4000 I. H. P., to give a speed of 19 knots. The armament will consist of two 12-cm. (3.9-inch) Q. F. and four 6-pounder Q. F. guns, with one torpedo-tube.

[Brazil.]

Coast Defense Battle-ships.

The two small coast-defense battle-ships building for this government at the La Seyne Yard, near Toulon, are to be called the Marshal Deodoro and Marshal Ypiranga. Their dimensions are to be as follows: Length, 267 feet 6 inches; beam, 48 feet; displacement, 3162 tons, with a draught of 13 feet 2 inches. Protection will be afforded by a water-line belt of 13.7 inches of nickel steel, tapering, however, to about half that thickness at the bow and stern, and by an armored deck 1.3 inches thick. There will also be a central redoubt protected with 28-inch nickel steel armor, and two armored turrets 8 inches thick, one forward and one aft, for two heavy guns, which will be 24-cm. (9.4-inch) Canet guns; four 12-cm. (4.7-inch) Q. F. guns will be mounted in the redoubt and two 15-cm. (5.9-inch) howitzers on the spar deck, with four 6-pounder, two 1-pounder Q. F. guns, two machine guns and two submerged tubes. The engines will develop 3400 I. H. P., steam being supplied by Lagrafel d'Allest water-tube boilers, and the speed is to be 15 knots. The coal storage will be 236 tons, and the crew will consist of 200 officers and men.

The Caramuru.

The new torpedo cruiser Caramuru, one of three building at the Germania yard at Kiel for the government, has lately completed her steam trials, when a mean speed of 22 knots was obtained. The following are the dimensions of the Caramuru and her two sisters: Length, 255 feet 6 inches; beam, 29 feet 6 inches; and with a draught of 9 feet 9 inches they have a displacement of 1030 tons. The engines are to develop 6000 I. H. P., giving a speed of 23 knots. The armament consists of two 4-inch, six 6-pounder, and four 3-pounder guns, all Q. F.'s, with two broadside and one bow tube for 18-inch torpedoes. Two first-class torpedo-boats are building at Elbing, and two river monitors at Rio de Janeiro.—*Journal of the Royal United Service Institution.*

[Chili.]

Esmeralda.

The new first-class cruiser Esmeralda has just been completed by Sir W. G. Armstrong & Co., at Elswick, for the Chilian Government. She may, perhaps, be regarded as a very much improved Blanco Encalada, which was completed in 1894 for the same government. She has a much more powerful armament, greatly increased protection, greater speed, and a larger coal-carrying capacity than the last-named ship; and now that she has satisfactorily passed through all her trials, and is lying ready to start for her destination, she must certainly be regarded as one of the most formidable cruisers afloat. A brief description will convince any one of this who will take the trouble to compare her qualities with those of cruisers of the same and greater displacement belonging to other nations.

Her length between perpendiculars is 436 feet; beam, 53 feet 2 inches; mean draft, 20 feet 3 inches, and a displacement of just over 7000 tons. Her full coal supply is 1350 tons, an amount which would enable her to cross the Atlantic at a speed of over 20 knots and, of course, give her an enormous radius of action at more moderate speeds. The vessel is

sheathed with wood and coppered. Her armament is as follows: Two 8-inch Q. F. guns, placed one forward and one aft; sixteen 6-inch Q. F. guns, four firing right forward and four right aft, and the remaining eight on the broadsides; eight 12-pounder Q. F. guns, ten 6-pounder Q. F., four Maxim guns, and three torpedo-tubes.

In addition to a curved protective deck, 1½ inches to 2 inches in thickness, extending over her whole length and covering all the vitals of the ship, she has over more that three-fourths of her length a belt of Harveyized armor 6 inches thick and 7 feet deep, terminated by armor bulkheads of the same thickness. Her conning tower, containing all apparatus for working and fighting the ship, is protected by Harveyized armor 8 inches thick.

The Esmeralda was commenced during the latter half of 1895, and she has been complete for some weeks, so that she has been considerably less than a year and a half building—a remarkably short time for a vessel of her size and power. Her machinery is of the four cylinder vertical triple-expansion type, driving twin screws; and the I. H. P., which was exceeded on trial, is 15,000 with natural draught. She is provided with forced draught, which would give her a power of 18,000 horses, but the Chilian Commission has been so satisfied with the results of speed and power attained with natural draught that no use has been made of forced draught.

Her official steam trials took place in September, and consisted of a full-speed trial with natural draught, which lasted for six consecutive hours. During the trial runs were taken on the measured mile, and a mean speed of over 23 knots was obtained with and against the tide, and the H. P. which gave this speed was maintained and part of the time exceeded during the six hours. In addition to the above, an endurance trial was taken lasting 24 hours, during which three-fifths of the full power, namely, 10,800 horses, was maintained, giving the vessel a speed of over 20 knots per hour.

The gun-firing trials took place off the Tyne on February 16th, the guns and structure of the ship being put to the severest possible tests. The 8-inch gun and four 6-inch guns were fired simultaneously in the line of the keel and horizontally, the shot passing only a few feet above the deck over the admiral's state-room, and yet no damage was done. All the guns were also fired simultaneously by electricity, which is also used as the motive power for training the 8-inch guns and the hoists for the 8-inch and 6-inch ammunition.—*Journal Royal United Service Institution.*

The official trial of the torpedo-boat Injeniero Hyatt, built by Messrs. Yarrow & Co. for the Chilian Government, took place at the mouth of the Thames on Monday, February 15th, when a speed of 27.2 knots was obtained over the Maplins with a pressure of steam of 195 lbs. This vessel and the torpedo-boat Cirujano Videla, tried last month, are being fitted out to join the Chilian squadron, which will shortly leave this country.

[JAPAN.]

Japan's Navy in 1906 will, according to present plans, consist of 6 line-of-battle ships, 12,517 to 15,140 tons; 1 second-class battle-ship, 7315 tons; 6 first-class armored cruisers, 9000 tons; 7 second-class cruisers of over 4000 tons; 6 third-class cruisers of over 3000 tons, and 12 fourth-class cruisers or gunboats of over 1500 tons.

[China.]

At the Vulcan Shipbuilding yard, Bredow, near Stettin, where the Chinese torpedo gunboat Fei Ying was built in 1895, three protected cruisers for the Chinese Government are in hand. They are sister ships of 2950 tons, 328 ft. long, with 41 ft. beam and 16 ft. 6 in. extreme draught. Protection is given by steel decks varying in thickness between 1½ in. and 2½ in., and the guns are to have steel shields. The armament will consist of three 6-in. and eight 4-in. Krupp quick-firers, six 1.4-in. Hotchkiss quick-firers, and six Maxims, and there will be three above-water torpedo-tubes. The machinery has been built at the Vulcan Works, and engines of 8000 horse-power, driving twin screws, are to give a speed of 19.5 knots. The normal coal supply of each cruiser will be 220 tons, and her complement 250 officers and men. At the same yard the German second-class cruisers K (5650 tons) and N (5900 tons) are in hand.

BOOK NOTICES.

THE ROYAL NAVY, by Wm. Laird Clowes, a history of England's Navy from the earliest times to the present, will appear in five royal 8vo volumes, with 25 photogravures and many full page and other illustrations, maps, charts, etc.; published by Sampson Low, Marston & Company, Limited, London.

Volume I., from the beginning to 1603, is nearly ready; it will extend over 700 pages. The remaining volumes will appear at intervals of about six months. Each volume will be complete in itself, with an index.

Mr. Clowes is assisted by Sir Clement Markham, K. C. B., P. R. G. S., Captain A. T. Mahan, U. S. Navy, Mr. H. W. Wilson, Mr. Theodore Roosevelt, Mr. E. Fraser and others.

Captain Mahan is preparing the campaign of the American Revolution, and Mr. Roosevelt that of the War of 1812 to 1815. The co-operation of American and English writers in the preparation of this work must commend itself to all students of history, establishing the fact that the historical verdict of both parties is substantially the same.

ALMANACH FÜR DIE K. U. K. KRIEGS-MARINE, 1897, Redaction der "Mittheilungen aus dem Gebiete des Seewesens," Pola. Price 4 Mark, 20 Pf.

This Marine Almanach replaces the former annual by the same publishers, viz., Almanach der Kriegsflotten, and it has become a more voluminous edition, the present number containing 485 pages, with 192 plates of battle-ships. Part I. is devoted to tables of weights, measures, and reductions from metric to English measures. Part II. contains tabular statistics of the Austrian Merchant Marine, with complete lists of merchant steamers. Part III. is devoted to the Imperial Yacht Club, containing lists of members and of the yachts. Part IV. contains interesting data on the pay in the Imperial Austrian Navy, regulations concerning pay of the personnel while on active service, on various detached service, pensions, pilot fees, regulations governing admission into the Naval Academy, medical corps, pay corps, etc. Part V. tabulates the data for naval ordnance of all nations. Part VI. contains the navy lists of the world, concluding with a comparative table showing the relative strength of the navies in battle-ships, cruisers, torpedo-boats and submarine boats. The fund of useful information contained in this handy pocket annual recommends it, irrespective of the fact that it is the product of the editorial office of the Mittheilungen aus dem Gebiete des Seewesens, a long-standing authority on naval matters.

THE 10TH ANNUAL OF AIDE-MÉMOIRE DE L'OFFICIER DE MARINE, 1897, by Edouard Durassier, continued by Charles Valentino, published by Henri Charles Lavauzelle, Paris, continues its high standard as a book of reference on naval matters.

As heretofore, the book opens with a comparative table of the modern navies of the world, followed by a recapitulation of naval events of the different nations during the past year. Besides the notes on international law, personnel, vessels, artillery, torpedoes, submarine cables, and various reduction tables, there have been added in this edition tables showing the distances of the French naval and military ports from the principal ports of the world, also the principal formulæ in geometry and trigonometry.

The book appears in its usual genteel form, with no increase in the moderate price of 5 francs.

The Naval Pocket-Book, 1897, by W. Laird Clowes, published by Neville Beeman, Ltd., London, is the second issue of the handy pocket reference book, the first issue of which last year was hailed with pleasure as filling a long-needed work of this kind in the English language.

This volume is somewhat larger than last year's issue, due to the introduction of numerous additional plans of ships and the admission of fresh matter.

As stated in the preface, an effort has been made, as before, to present in a manner favorable for reference and comparison the statistics of the various navies; and, with this end in view, while the official classification of vessels has been retained, a secondary classification, based upon power, size, speed and newness, has been introduced.

As a result of this secondary classification throughout the work, ships of approximately equal fighting value may be recognized at a glance on reference to the letters A, B, C, D., etc., under which they are ranked.

After the classified list of navies follow a summary of ships of the more important classes belonging to leading navies; notes on guns and small arms, on torpedoes, on naval personnel and comparative rank; lists and particulars of dry docks; miscellaneous tables of weights and measures and their conversion from metric into English system or reverse; concluding with trial-trip tables. H. G. D.

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[AMERICAN.]

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JANUARY 2, 1897. Compressed Air in Working Guns. Samohod's Nautical Register.

JANUARY 9. Military Ballooning. New Docks at Gibraltar. Homing Pigeons. Nickel Steel.

JANUARY 16. Commercial Navies of the World.

JANUARY 23. Antarctic Explorations.

JANUARY 30. 1000 Horse-power Boilers.

FEBRUARY 6. Russia takes American Armor Plate. The Cruiser Terrible. Rapid Military Firing.

FEBRUARY 13. Stability of the Battle-ship Indiana. Our New Torpedo-boats.

FEBRUARY 20. The Brooklyn Navy Yard Timber Dry Dock.

The dimensions of the new dock No. 3 are: Length on coping, 670 feet; breadth on coping, 151 feet; depth of water on sill, 29 feet.

FEBRUARY 27. Lessons of the Naval Manœuvres. The Freight Steamer Pennsylvania of the Hamburg-American Line.

This is in some respects the largest ship in the world, her principal dimensions being as follows: Length, 560 feet; beam, 62 feet; depth, 42 feet; maximum draught, 30 feet; loaded displacement, 23,400 tons; horse-power, 5500; speed, 14½ knots.

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JANUARY, 1897. Society in Washington. Ball's Bluff. Rear-Admiral James Edward Jouett, United States Navy. Some Experience with the Cheyennes. The World beneath the Ocean.

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JANUARY 7, 1897. The Kearsarge and Kentucky Plates. The Cost of Armor Plate.

JANUARY 14. Roller Bearings in Steam Engines. A large Car Ferry Boat.

JANUARY 21. Inspecting Steel Plate for the Navy. The Bethlehem Plate Mills (illustrated). The Cost and Price of Armor Plate.

JANUARY 28. Steel Productions in Great Britain in 1896. Bearings of Marine Engines. The New Magazine Rifle. Aluminum-coated Sheets. Cost of Armor Plate.

FEBRUARY 4. The German-Austrian Mannesmann Tube Works. Naval Steel Inspectors. The Tendency of Naval Armaments.

FEBRUARY 11. The Incandescent Lamp—Past and Future.

FEBRUARY 18. Test of Armor Plates. The Armstrong-Whitworth Consolidation. Torpedoes in the Navy.

FEBRUARY 25. Progress of Naval Vessels building.

MARCH 11. Encourage American Shipping. Collapse of a Pair of Corrugated Furnaces (illustrated). Swedish Armament.

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JANUARY 30. The Blake Twin Vertical Air Pumps in the Kaiser Wilhelm der Grosse. The Bearings of the Marine Engine. Removing a "Shrunk-on" Gun Jacket.

FEBRUARY 13. The Indianapolis Pumping Engine. The Engines H. M. S. Swordfish and Spitfire. The Slide Valves of the Terrible, R. N. The Bazin Roller Steamship. Advantages of Mechanical Stoking. Proposed Use of Compressed Air on Men-of-War. Efficiency and Management of Steam Boilers.

MARCH 13. Pitting and Corrosion of Steam Boilers.

SEABOARD.

JANUARY 7, 1897. Our own Ships for our Foreign Trade.

JANUARY 14. Progress and Promise in American Shipbuilding.

JANUARY 21. A New Sleeve Sounding Lead.

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JOURNAL OF THE ASSOCIATION OF ENGINEERING SOCIETIES.

DECEMBER, 1896. The Galveston Harbor Works. Structural Strength of Ships and improved Arrangements for Repairing them without Diminution of their Strength.

FEBRUARY, 1897. Resistance of Ships and other Floating Bodies at Deep and Shallow Drafts of Water.

THE JOURNAL OF THE FRANKLIN INSTITUTE.

JANUARY, 1897. The Standard of Efficiency for Steam Engines and other Heat Motors.

FEBRUARY. Speed Variations in Crank Shafts. Aluminum Alloys. Aluminum Manufacture in Europe. The Storage Battery in Europe.

MARCH. Ice Caves and the Causes of Subterranean Ice. Equalizing Connections for Compound Wound Dynamos coupled in Multiple. Domestic Statistics of the Aluminum Manufacture in 1896.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

FEBRUARY, 1897. A Method of Determining a Continuous Record of the Performance of a Marine Engine. The U. S. S. Terror and the Pneumatic System as applied to the Guns, Turrets and Rudder. The Speed Problem. On Crank Shafts. Hollow Steel Forgings. Steel Forgings. Machinery Bearings. The Bearings of the Marine Engine.

ELECTRICAL ENGINEERING.

MARCH, 1897. Calculations of Circuits.

CASSIER'S MAGAZINE.

JANUARY, 1897. Boiler Feed Pump Efficiency. Power Transmission from Niagara Falls. American Lake and Ocean Steamship Models.

FEBRUARY. The Whitehead Automobile Torpedo. Steamboats on Western American Rivers. Ancient Pompeiian Boilers. The Bazin Roller Boat.

Full illustrated description of the Bazin. After an account of the experiments with the first models, the author states: "These experiments will be repeated on a much larger scale when the Ernest Bazin is made ready for its trial trip, and many of the French naval experts and marine engineers expect that they will be equally successful. The present boat is intended only for service in the English Channel and other coast waters, but in the event of its success it may be the forerunner of a fleet of transatlantic liners, constructed on the same principles, with such modifications as experience may suggest."

MARCH. Some Early American Steam Craft. The Age of Electricity. Electrically Annealing Armor Plates on a Battleship.

PROCEEDINGS AMERICAN SOCIETY OF CIVIL ENGINEERS.

VOL. XXIII, No. 1. Wind Pressures in the St. Louis Tornado (illustrated).

JOURNAL OF THE U. S. CAVALRY ASSOCIATION.

DECEMBER, 1896. The Screening Duty of Cavalry. Night Operations (concluded). Scott and Harney: an Official Episode of the Mexican War. The Practical Work Course in Engineering for Cavalry Officers at the Infantry and Cavalry School.

AMERICAN ELECTRICIAN.

JANUARY, 1897. An Electric Yacht. Mechanical Stokers and Shaking Grate Bars. The Equalizer. How to make an Induction Coil. The Steam Engine Indicator. Faults of Railway Motors—their detection, cause and remedy.

FEBRUARY. An Interesting Example of Practical Expedients. Rotary Converters. Dynamo Characteristics. The Slide-valve Diagram. Lessons in Practical Electricity.

MARCH. Application of Electricity to Bank Burglary. The Storage Battery in Telegraph Work. How to make a Telephone. Lessons in Practical Electricity.

[FOREIGN.]

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

DECEMBER, 1896. Biographical Sketch of His Majesty William II., German Emperor and King of Prussia, K. G., etc. The Functions of the Navy and Army in the Defense of the Empire. On Pistols. The Highland Rising of the '45 from a Military Point of View. Lime Juice. The use of Aluminum for Military Purposes.

JANUARY, 1897. The New Chilian Armored First-class Cruiser Esmeralda. Recognition of Belligerency considered in relation to Naval Warfare. The Evolution of the Militia as the Basis of the Army. Notes on Tactics for Ships and Weapons of the Present Day.

FEBRUARY. On the Employment of Retired Bluejackets, Soldiers and Marines. The Invasion of England: should London be Fortified? Notes on Tactics for Ships and Weapons of the Present Day (Part II).

MARCH. The New French First-class Battle-ship Carnot. The Militia in 1897. On Company Field Training. German Naval Policy and Strategy.

ENGINEERING.

DECEMBER 25, 1896. The American Society of Naval Architects and Marine Engineers (illustrated). The Machinery of the S. S. Kherson (illustrated). Canet Naval Guns (illustrated). Shipbuilding and Marine Engineering in 1896 (illustrated).

JANUARY 1, 1897. Shipbuilding and Marine Engineering in 1896. Water-tube Boilers. Torpedo-boat Destroyers Furor and Terror (illustrated). The Manufacture of Aluminium. The Bearings of the Marine Engine.

JANUARY 8. The New Mersey Pilot Steamers. Experiments in Steel-making in Japan. Shipbuilding and Marine Engineering in 1896.

JANUARY 15. The Engines of H. M. S. S. Swordfish and Spitfire. Water-tube Boilers. The Pumps of the Kaiser Wilhelm der Grosse. The Bazin Roller Ship. The Trials of H. M. S. Terrible.

JANUARY 22. Submarine Telegraphy. American Opinions of Japanese Industry.

JANUARY 29. New Rifle for the United States Navy. Labor on Government Work.

FEBRUARY 5. The Japanese Battle-ship Yashima (illustrated). Military Works. The Russian Pyrocollodion Powder.

FEBRUARY 12. Fiske's Engine Telegraph and Speed Direction Indicator (illustrated). The Russian Pyrocollodion Powder.

FEBRUARY 19. The Russian Pyrocollodion Powder. The Machinery of the Japanese Battle-ship Yashima (illustrated). Submarine Telegraphy. The Jaureguiberry and Boiler Tubes. The Prevention of Vibrations of Steamships (illustrated).

FEBRUARY 26. The Prevention of Vibrations of Steamships. Twin-screw Engines of the Japanese Battle-ship Yashima (illustrated). The Launch of H. M. S. Niobe (illustrated).

MARCH 5. The Launching of H. M. S. Niobe (illustrated). The Navy Estimates. The Cruiser Pegasus and the Destroyer Flying Fish.

MARCH 12. Thames-built Battle-ships (illustrated). The Navy in Parliament. British Battle-ship Jupiter.

MARCH 19. Hamlyn's Collapsible Boat Chocks (illustrated). The Navy Estimates. The British Cruiser Pelorus (illustrated).

THE ENGINEER.

DECEMBER 25, 1896. H. M. S. Prince George. H. M. S. Albion.

JANUARY 3, 1897. Armor for the Kearsarge and Kentucky (illustrated). Shipbuilding for 1896. Corn-pith Cellulose. War Material. New American Battle-ships.

JANUARY 8. Modern Japan: III. The Yokosuka Dock Yard. The Bearings of the Marine Engine (illustrated).

JANUARY 15. Absence of a Standard in Battle-ship Design. Comparative Cost of English and American Boilers. H. M. S. Terrible. New Battle-ships.

JANUARY 22. Attack on Fortifications by Ships. Maritime Improvements at Dunkirk. H. M. S. Prince George: Capstan Gear. Trial of Cammell's 6-in. Plate.

JANUARY 29. A New Secondary Battery. Who was the Pioneer of Armor Plates? The Johnson Capped Shot (illustrated). The Kherson (illustrated). Defects in French Battle-ships.

FEBRUARY 5. Our Present Position in Ordnance and Armor. Diagrams from the Engines of H. M. S. Powerful (illustrated). Modern Japan: Industrial and Scientific: No. V (illustrated). Sir W. Armstrong, Whitworth & Co., Limited.

FEBRUARY 12. Tests of an Experimental Turret of the U. S. Battle-ship Massachusetts. The Maxim-Cordite Case.

FEBRUARY 19. New Canet Quick-fire Gun for the Greek Navy (illustrated). The Battle-ship Ocean.

FEBRUARY 26. German Naval Estimates. The New Cruiser Niobe. Russian Armor Trial. The Japanese Battle-ship Fuji.

MARCH 5. Watt and the Measurement of Power. The Cordite Case. Baxter's Steering Gear. A New Sectional Gun (illustrated).

MARCH 12. The Programme and Estimates for 1897–8. Water-tube Boilers and Liquid Fuel.

MARCH 19. U. S. Monitor Puritan (illustrated). Accident to the Corrientes Torpedo-destroyer (illustrated). Recent Trials of Firth's Shot and other Armor-piercing Projectiles.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

JANUARY, 1897. Report on the German Manœuvres of the XIV. German Army Corps in Baden, September, 1896. African Animals. The Duties in Action of the Lieutenant-Colonel Commanding a Siege Train Division. Artillery from an Infantry Officer's Point of View.

FEBRUARY. A Two Months' Trip into Mongolia. Artillery Positions and Screening Guns. Formula for finding Speed of Objective. A Plea for Speed Firing with Garrison Artillery Guns. The German Method of bringing Guns into Action. Colonel James Wemyss. Captain Bogue and the Rocket Brigade. Mountain Artillery Drill.

THE STEAMSHIP.

JANUARY, 1897. Internal Corrosion in Steam Boilers. Launch of a Brazilian Cruiser at Elswick. Launch of the Cruiser Furious. Marine Engineering Returns for 1896. A New Marine Engine.

FEBRUARY. Clyde-built Light-draught Steamers. The Bearings of the Marine Engine (illustrated). Atlantic Records during the Past Year. Submarine Cables and their Enemies. German Shipbuilding Trade. The "Harman" Patent Feed-water Heater (illustrated).

MARCH. Marine Boiler Explosions. The Edison & Swan Electric Light Fittings for Ships (illustrated). O'Brien's Watertight Doors for Ships (illustrated). Thrust Bearings for Propeller Shafts (illustrated). Suction *vs.* Forced Draught for Marine Boilers. Marine Propellers. Trial Trip of H. M. S. Isis.

UNITED SERVICE GAZETTE.

JANUARY 2, 1897. A Year's Warship-building. Methods of Manning the Navy.

JANUARY 9. The Armament of Cavalry—II.

JANUARY 16. Steam Engineering in the United States Navy.

JANUARY 23. The Victory of Shot over Armor.

JANUARY 30. The Effect of Electricity on the Flight of Projectiles.

The Committee of the Federal Shooting Association made a curious discovery lately in tabulating certain results of shooting. It observed that on the range at Winterthour the majority of shots fired at the targets on the right of the range struck to the right of the bull's-eye, while on the targets on the left of the range the greater number of hits were to the left of the bull's-eye. It was further discovered that all the projectiles constructed either partly or wholly of steel had become magnetized during flight.

The Federal Experimental Committee having had these facts brought to their notice, thought that possibly they might have some connection

with the existence of the numerous wires used for electric bells and telephones on either side of the range. Several additional experiments were made on other ranges and the results fully bore out this theory.

An electric current of 8000 volts was installed on the range at Thun by means of four 18-mm. cables laid parallel to the line of fire and 40 m. from it. In order to define the trajectory, screens of thin paper were fixed at every 10 m. along the range.

The first trials were made with the 1889 pattern rifle. The influence of the electric current made itself felt at once; at 260 m. the lateral deviation was already 24 m. The trajectory showed a very remarkable curve towards the electric current.

A second trial was made with the Japanese gun of 3.3 mm. invented by Colonel Yamagata. The minute bullet went straight for the electric wires, broke two insulators, and followed along the wires, finally wearing out its energy with the friction.

Experiments were then made with artillery. The results obtained were no less startling. The range was 3000 m. and the electric current was installed as before, commencing at 2800 m., *i. e.* 200 m. in front of the target. The lateral deviation of the shell (common) was 14 degrees. Firing with shrapnel produced even more curious phenomena. The head of the projectile, carrying the fuse made of a non-magnetic metal, was completely detached, while the body was attracted by the current, the bullets after burst showing such extraordinary variations that all accuracy of fire was totally done away with.

It was proved by these experiments that the force of attraction increases in inverse ratio to the weight of the projectile and also to its velocity. A section of infantry exposed to the fire of hostile infantry at 300 m. and having on one flank an electric current (by means of a dynamo or accumulators) would have nothing to fear from the enemy's bullets. A company at 500 m. could be protected in a similar way, and a like arrangement would be a safeguard from artillery fire at from 900 to 1400 m.

FEBRUARY 6. Control of the Dardanelles. British Command of the Sea.

FEBRUARY 13. The Naval Defense of Australia. Hygiene in the Navy.

FEBRUARY 20. The Defense of Great Britain. Homing Pigeons.

Good progress has been made this week with the erection of a pigeon loft at Mount Wise, Devonport, where it is proposed to keep about two hundred birds to be trained as seafaring messengers. The light walls on which the loft will rest are nearly completed, and the loft is expected to be ready for use by the end of March. It is understood that a sum of £300 or £400 will be voted in this year's estimates for erecting a pigeon loft at Rat Island, Portsmouth, in the immediate vicinity of the Victory, where the signaling instruction is carried on.

Hygiene in the Navy (II.).

FEBRUARY 27. A Naval Tactical School.

MORSKOI SBORNIK.

DECEMBER, 1896. Suggestions for increasing the Efficiency of our New Ships (translation of article from Naval Institute Pro-

ceedings, by W. J. Baxter). Commerce Destroyers in War. Armament of German Fleet. Extent of Influence of Damage to Side upon the Stability of the Ship. Water Tubular Boilers on Ships of War. The Gyroscope Collimator. Shipbuilding Abroad. Loss of French Torpedo-boat No. 83. Bursting of Steam Pipe on board the Huascar.

JANUARY, 1897. "Old and New": comparison of Russian and British Admiralty Organizations. Considerations upon Questions in Naval Tactics (Admiral Makaroff). Commerce Destroyers in War. Comparative Strengths of the Fleets of the Chief Naval Powers. Trials of the Machinery of the English Cruiser Powerful. Meteorology as a Factor in Time of War. Naval Construction Abroad. Experience of the British Cruiser Talbot in a Gale. Bursting of Boiler on Swedish Torpedo-boat. Notes on Hydrography and Physical Geography.

FEBRUARY. Considerations upon Questions in Naval Tactics. Comparative Strengths of the Fleets of the Chief Naval Powers. Commerce Destroyers in War. Preservation of Locomotive and Water Tube Boilers. Torpedo Nets for War-ships. The Grounding of the Cruiser Russia. Naval Construction Abroad. Collision of the Blenheim with the French Sailing Ship France. Bursting of Boiler on Swedish Torpedo-boat. Hydrographic Notes. Ordnance Notes: New English 6-in. Guns. Adoption in the German Navy of large-calibre, quick-firing Guns up to 9.45 in. J. B. B.

MILITÄR WOCHENBLATT.

No. 1, 1897. Canet Field-piece, M. 1896.

NOS. 7 AND 8. Small Arms. Instructions in Use of Arms.

No. 9. Camp Utensils of Aluminium in France. Breech-closing Apparatus of Rapid-fire Guns.

No. 16. Weight of English Shrapnel. New Austrian Guns for Fortifications.

NOS. 17 AND 18. Estimating Distances. Russian Naval and Military Estimates for 1897.

No. 19. Infantry Rifles.

Gives development of the military rifle from 1550 to present time. The tables show that the weight of the rifle has been nearly constant during the 400 years. It is only within the past 15 years that any marked reduction in weight has occurred, from about 10 lbs. to 8.4 lbs. The calibers have been decreasing from 17.5 millimeters (.68 in.) to as low as 5 millimeters (.19 in.)

DEUTSCHE HEERESZEITUNG.

No. 102, DECEMBER 19, 1896. Aid to Wounded on the Battlefield. Increase of Italian Navy.

Nos. 1 and 2, 1897. New Shipbuilding Programme for 1897, from first reading in the Reichstag.

No. 3. Wounds made by Modern Rifle Bullets, and Choice of Field Hospitals.

Colonel Bricher, corps surgeon of the 2nd Swiss Army Corps, has made, during two years, extensive researches as to the effect of modern bullets and the dependent choice of field hospitals. He believes that the total percentage of losses calculated with reference to the whole army will not increase, but that the percentage will be greater in case of troops actually engaged. He believes that the number of killed, as compared to the wounded, will increase, and the injury to blood-vessels will lead to increased cases of bleeding to death. His comparisons are as follows: Past battles—wounds in the head, 12; body, 18; upper limbs, 30; nether limbs, 40 per cent.. Future battles—head, 20; body, 15; upper limbs, 30; nether limbs, 35 per cent. An increase in the number of heavy wounds is not probable, notwithstanding the severe shattering of bones at great distances.

Canet Rapid-fire Gun, Model 1896.

No. 7. French Naval Programme for 1897. Comparison of Fleets of Chili and Argentine.

Nos. 12 and 13. Holland's Shipbuilding Programme. Losses in Men-of-war and Personnel during the year 1896. Comparison of Navies of Principal Nations.

No. 15. French Ships of War to be completed 1897 to 1902.

No. 17. Trafalgar and to-day.

Nos. 18 and 19. The German Navy, from first reading in the Reichstag. Trafalgar and to-day (continued).

MARINE RUNDSCHAU.

January, 1897. The History of the Imperial Navy (continued). On Observations made during Launchings (with three plates).

It has been the custom in recent years to make certain fixed measurements and observations during launchings from the Imperial dockyards at Kiel and Wilhelmshaven.

The object of these measurements was to determine what conditions of motion and resistance arise in direction of descent, in order to determine from these the influence of total weight, surface pressure, temperature, kind and amount of lubricating material upon the coefficient of friction, as well as the proper incline of the ways.

Furthermore, it was attempted to measure the motion of the ship in a direction at right angles to the ways, in order to answer the following special questions: Were the ways deformed by blocking up? Was any hogging of the ship caused by insufficient length of ways? Was the ship water-borne too soon or too late? Did any grounding take place?

This interesting paper describes the apparatus used, with illustrations, and results of determinations in the cases of launchings of the Falke, Kaiserin Augusta, Hagen, Kolmar, Aegir and Bonn.

Trial Trips of H. M. S. Odin. The United States Navy (concluded). Naval Notes.

FEBRUARY. The History of the Imperial Navy (continued). Raising of the Steamer John Siem, sunk in Kaiser Wilhelm Canal. The Nicaragua Canal. Our Sailors' Uniforms. Naval Notes.

MARCH. The History of the Imperial Navy (continued). Search-light for Army and Navy. The Iltis Typhoon of July 22 to 25, 1896. The Hongkong Plague Epidemic. Development of the German Colonies. Foreign Naval Notes.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

No. I., 1897. Remarkable Changes in the Deviation of the Steamer Phoenicia's Standard Compass during her first Year's Trips. Lunar Observations for determining Ship's Position at Sea.

No. II. Photography on board Ship.

Instruction in uses of camera, development, dark room, etc.

Organization, Development, latest Improvements, and present Status of French Lighting Systems. Ground Ice in Sea Water.

MITHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOL. XXV., No. II. The Exploring Expedition of H. M. S. Pola in the Red Sea, 1895 to 1896. Armor Trials of Witkowitz Plates (illustrated). New Battle-ships of the United States. Captain Gaynor's Automatic Sight. The Simplex Ice Machine of Duncan, Stewart & Co. Speed of Torpedo-boat Destroyers. Fishing with Use of Electric Lights. Foreign Navies.

Nos. III. AND IV. Austria's War in the Adriatic in the year 1866. H. G. D.

LE YACHT.

No. 980, DECEMBER 19, 1896. The Navy Estimates. The Loss of the Salier: Variations of the Compass near the Coasts of Spain.

No. 981, DECEMBER 26. The Navy in Parliament.

The animated debates on the navy bill show conclusively that France is alive to the inferior position in which she finds herself placed in regard to the European maritime nations, with whom she may become involved in war in the near future, and has come to the conclusion that her naval policy consists in the building of powerful rapid cruisers, at least twenty of them, limiting armor protection to protective decks, and belted waterlines extending only part of the length of the ship. Mortar-avisos are thought preferable to destroyers, because they are capable of attacking battle-ships and bombarding cities, and prove at the same time a formidable match against torpedo-boats.

No. 982, JANUARY 2, 1897. The New Constructions.

No new fact of a general order developed during the year 1896. The contest goes on between armor and high explosive projectiles. Already the latter penetrate plates of a medium thickness of 150 mm. on the upper works, where their effects will prove all the more destructive, as they will explode in the interior of vessel. Will it be possible to increase still further the thickness of these plates and thereby augment the weight of the superstructures? The limits of the defensive power must soon be reached, whilst those of the offensive are still a great way off. The solution of the problem will likely be found in a return to the monitor class of vessels and the high-speed cruiser, aided by the gunboat and the torpedo-boat. Only two armored battle-ships were launched, the Gaulois and St. Louis, of the Charlemagne class, 11,725 tons, 14,000 horse-power and 18 knots, besides the first-class cruiser d'Entrecasteaux, 8114 tons, 14,000 horse-power and 19 knots; the second-class cruisers Cassard, D'Assas and Catinat, 3952 and 4065 tons, 9500 horse-power and 19.2 knots; finally, the third-class cruiser Galilée, 2320 tons, 6400 I. H. P. and 20 knots.

No. 983, JANUARY 9. The French Navy in 1896. The Steam Ferry-boat Finnieston.

No. 984, JANUARY 16. The Question of the Personnel in the Navy.

No. 985, JANUARY 23. Apropos of Naval Strategy.

In his article, M. Em. Duboc advocates the use of commerce destroyers in a possible war with England, and cites the immense losses caused by the Alabama during the War of the Rebellion.

No. 986, JANUARY 30. The English Cruisers Blake and Blenheim. The United States Navy.

No. 987, FEBRUARY 6. The Navies of the World.

A review of the fleets of the principal maritime nations.

No. 988, FEBRUARY 13. The French Mediterranean Squadron.

Major A. Court, in a recent article in the Nineteenth Century, undertakes to examine the French naval policy and makes a picture of the fleet which is anything but reassuring. Commenting upon the article, M. Em. Duboc proposes some reforms in the administration of the department, tending in some extent to remedy the situation.

No. 989, FEBRUARY 20. Naval Tactics and Strategy (Em. Duboc).

The writer deplores the absence of interest in naval tactics and of well defined strategic plans in view of an eventual conflict with England.

No. 990, FEBRUARY 27. Endurance of Boilers and Engines.

J. L.

LE MONITEUR DE LA FLOTTE.

No. 2, JANUARY 9, 1897. War on Commerce (Guerre de course).

Rear-Admiral Dubasof, Naval Attaché at Berlin, has just delivered in the Library Hall of the Navy Department at St. Petersburg a very

interesting lecture on "Cruisers and Naval Warfare." Admiral Dubasof does not favor war on commerce, and says it is a mistake to think that this kind of warfare is an important factor in the final result, which can only be decided in a pitched battle between the two hostile fleets. The Admiral also believes that without the support of battle-ships, cruisers can render but little service, and is opposed to their dissemination in different parts to operate like so many Alabamas. As an offset to the preceding, in an article that appeared in the Revue Maritime of November last, Commander Farret contends that war on the enemy's commerce (especially when England is considered) may have very appreciable results. In case of the well-marked inferiority of one of the combatants and the immense commercial navy of the superior, commerce-destroying warfare becomes evidently the arm of the feeble against the strong. Commander F., however, sees difficulties in the way of such warfare, as, for instance, the dispositions to be made of the captured vessels with inadequate prize crews.

No. 5, JANUARY 16. Battle-ships and Cruisers: their Connecting Link.

No. 7, JANUARY 30. The Superior War College and the Capitaines de corvette: Advantages in reinstating the Grade.

No. 8, FEBRUARY. The Situation in Crete. J. L.

RIVISTA MARITTIMA.

DECEMBER, 1896. The Yarrow and Thornycroft Boilers. Use of Torpedo-boats.

JANUARY, 1897. Notes on Naval Strategy.

BOLETIN DEL CENTRO NAVAL.

DECEMBER, 1896. Williams: the Changes in the Armament of the Almirante Brown. Steel for Ordnance (continued).

JANUARY, 1897. Our Oceanic Coasts (apropos of the book of Sr. Chaigneau). Armor and Modern Projectiles. The Armored Battle-ship José Garibaldi.

RIVISTA DI ARTIGLIERIA E GENIO.

NOVEMBER, 1896. Graphics of Convergence. A Study on Telephony.

REVISTA TECNOLOGICO INDUSTRIAL.

DECEMBER, 1896. Railway Traction and the Means of facilitating it (continued). Altimetry: Measuring Heights by means of the Barometer, Hipsometer, etc. Association of Civil Engineers of Barcelona.

REVUE DU CERCLE MILITAIRE.

No. 51, DECEMBER 19, 1896. Alpine Military Shelters in Italy (end). Aluminum Camping Utensils in the French Army.

No. 1, JANUARY 2, 1897. The Corps of Frontier Guards in the Russian Army.

Nos. 3, 4. Organization and Use of Cyclists' Units in the Army.

No. 5. The Chinese Eastern Railway.

No. 6. The Spirit of Initiative in the Army.

REVUE MARITIME.

DECEMBER, 1896. A Note on the Behavior of the Chronometers of the Marceau. A Practical Guide to the Conduct of Court-martials and Courts of Inquiry on board of Men-of-war. The Electric Tachymeter. Remarks on Naval Tactics.

Commander Rudolf Labrés, of the Austro-Hungarian Navy, published in January and February, 1896, in the "Mittheilungen aus dem Gebiete des Seewesens," a study on naval tactics. The Revue gives an extract of this interesting work, pointing out its most salient features and insisting upon the new ideas emitted by the author. J. L.

REVIEWERS AND TRANSLATORS.

Lieut. J. B. BERNADOU, U. S. Navy. Lieut. H. G. DRESEL, U. S. Navy.
Prof. JULES LEROUX.

ANNUAL REPORT OF THE SEC. AND TREAS. OF THE U. S. NAVAL INSTITUTE.

To the Officers and Members of the Institute:

Gentlemen:—I have the honor to submit the following report for the year ending December 31, 1896.

ITEMIZED CASH STATEMENT.

Receipts during Year 1896.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Dues	$585 00	$706 89	$335 41	$360 51	$1987 81
Subscriptions	197 34	156 67	156 45	160 92	671 38
Sales	111 50	53 25	136 00	20 92	321 67
Interest on bonds	96 33	9 00	55 53	9 00	169 86
Advertisements	113 75	120 00	152 50	57 50	443 75
Binding	14 00	14 05	8 85	11 00	47 90
Life membership fee	30 00	. . .	30 00	30 00	90 00
Premium on money orders	40	. . .	53	. . .	93
Credit	50	. . .	. . .	. . .	50
Sale of check	. . .	. . .	17 00	. . .	17 00
Totals	$1148 82	$1059 86	$892 27	$649 85	$3750 80

Expenditures during Year 1896.

Items.	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Totals.
Printing	$6 50	$541 72	$1201 54	$382 15	$2131 91
Salaries	300 00	300 00	300 00	300 00	1200 00
Postage	39 13	46 53	50 46	36 68	172 80
Expressage	5 37	4 80	2 75	3 50	16 42
Freight and hauling	2 04	6 58	4 42	3 50	16 54
Binding	13 00	20 80	. . .	. . .	33 80
Stationery	7 84	38 35	95	1 25	48 39
Office expenses and furniture	1 55	. . .	3 00	41 00	45 55
Telegraph and telephone	15	89	40	25	1 69
Prize	100 00	. . .	. . .	. . .	100 00
Gold Medal	15 50	2 00	. . .	. . .	17 50
Rebates	. . .	10 70	. . .	93	11 63
Insurance	. . .	8 40	. . .	. . .	8 40
Purchase back No. and check	. . .	1 00	17 00	. . .	18 00
Purchase D. C. bonds R. F.	. . .	. .	. . .	110 75	110 75
Totals	$491 08	$981 77	$1580 52	$880 01	$3933 38

Summary.

Balance of cash unexpended January 1, 1895	$4423 99
Total receipts for 1896	3750 80
Total available cash, 1896	$8174 79
Total expenditures	3933 38
Cash unexpended January 3, 1897	$4241 41
Cash held to credit of reserve fund	59 14
True balance on hand January 1, 1897	$4182 27
Bills receivable for dues 1896	651 00
" " " back dues	856 75
" " " binding	22 00
" " " subscriptions	52 50
" " " sales	12 43
" " " advertisements	137 50
Value of back numbers (estimated)	2000 00
" " Institute property	100 00
	$8014 45

Reserve Fund.

United States 4 per cent. Consols, registered	$900 00
District of Columbia 3.65 per cent. registered bonds	2000 00
" " coupon bonds	650 00
	$3550 00
Cash in bank uninvested	59 14
	$3609 14

Membership.

The membership of the Institute to date, January 1, 1897, is as follows: Honorary members, 5; life members, 109; regular members, 570; associate members, 190; total number of members, 874.

During the year 1896 the Institute lost by death, resignations and dropped, 45 members. 35 new members' names were added to the rolls—17 regular, 6 associate, 4 life members; 3 regular members became life members—one, the prize essayist.

Members Deceased Since Last Report.

Honorary Members.

Jones, J. D., 1896.

Life Members.

Tyler, George W., Lieut.-Commander, U. S. Navy, Feb. 17, 1896.
McGiffin, Philo N., Captain, February 11, 1897.

Regular Members.

Stevens, Thomas H., Rear-Admiral, U. S. Navy, May 15, 1896.
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France, J. R., November 6, 1895.
McClymont, E. E., December 29, 1895.
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7	1	....	47	31	19
8	31	....	48	50	18
9	35	....	49	18	17
10		....	50	62	17
11	211	....	51	35	18
12	50	....	52	55	16
13	1	....	53	160	34
14	2	....	54	3	4
15		....	55	55	17
16	225	....	56	465	53
17		....	57	21	19
18	105	....	58	2	7
19	109	....	59	17	18
20	126	1	60		1
21	222	1	61	190	18
22	267	1	62	147	16
23	177	1	63	178	37
24	187	1	64	30	18
25	1040	43	65	124	18
26	212	90	66	17	16
27	300	27	67	10	15
28	2	15	68	160	9
29	208	9	69	156	16
30	247	4	70	150	18
31	35	50	71	26	16
32	17	173	72	237	19
33	10	162	73	230	19
34		1	74	232	19
35	139	5	75	227	19
36	278	29	76	228	19
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EXCHANGES (AMERICAN).

American Chemical Journal.
American Electrician.
Army and Navy Register.
Army and Navy Journal.
Baltimore Life.
Bulletin of the American Geographical Society.
Bulletin of the American Iron and Steel Association.
Bulletin of the Geographical Society of California.
Cassier's Magazine.
Colliery Engineer.
Electrical Engineer.
Engineering News and American Railroad Journal.
Engineer (New York).
Engineering-Mechanics.
Geographical Survey of Missouri.
Iron Age.
Journal of the American Society of Naval Engineers.
Journal of the Association of Engineering Societies.
Journal of the Franklin Institute.
Journal of the United States Artillery.
Journal of the United States Cavalry Association.
Journal of the Military Service Institution.
Lend-a-Hand.
Littell's Living Age.
Proceedings of the American Academy of Arts and Sciences.
Proceedings of the California Academy of Sciences.
Proceedings of the American Philosophical Society.
School of Mines Quarterly.
Scientific American.
Seaboard.
Stationary Engineer.
Technology Quarterly and Proceedings of the Society of Arts.
Transactions and Proceedings of the Geographical Society of the Pacific.
Transactions of the American Society of Mechanical Engineers.
Transactions of the American Institute of Mining Engineers.
Transactions of the American Society of Civil Engineers.
Transactions of the Connecticut Academy of Arts and Sciences.
Transactions of the Technical Society of the Pacific Coast.
United Service.

EXCHANGES (FOREIGN).

Annalen der Hydrographie und Maritimen Meteorologie.
Australasian Army and Navy and Defense Review.
Boletin del Centro Naval.
Boletin do Club Naval.
Bulletin l'Association Technique Maritime.
Conservatoire National des Arts Metiers.
Deutsches Heeres-Zeitung.
Engineering.
Engineer.
Journal of the Royal United Service Institution.
Journal and Proceedings of the United Service Institution of New South Wales.
Le Moniteur de la Flotte.
Marine Rundschau.
Militär Wochenblatt.
Minutes and Proceedings of the Institution of Civil Engineers.
Mittheilungen aus dem Gebiete des Seewesens.
Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
Morskoi Sbornik.
Norsk Tidsskrift for Sovaesen.
Proceedings of the Royal Artillery Institution.
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Revista Maritima Brazileira.
Revista Tecnologico Industrial.
Revue du Cercle Militaire.
Revue Maritime.
Rivista di Artiglieria e Genio.
Rivista Marittima (Rome).
Steamship, The.
Teknisk Tidskrift.
Tidskrift i Sjovasendet.
Transactions of the Canadian Institute.
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United Service Gazette.
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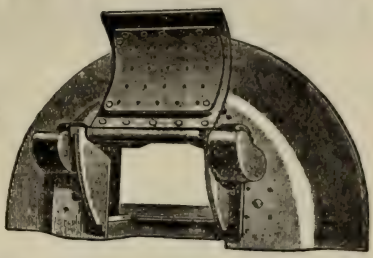

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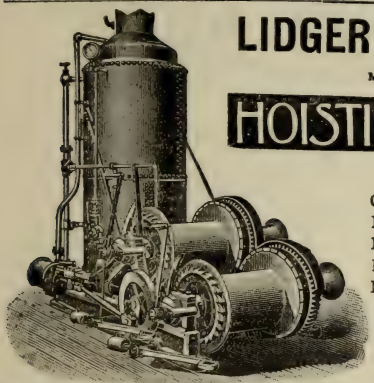

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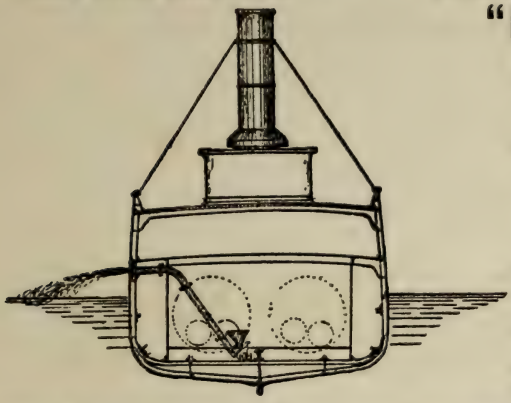

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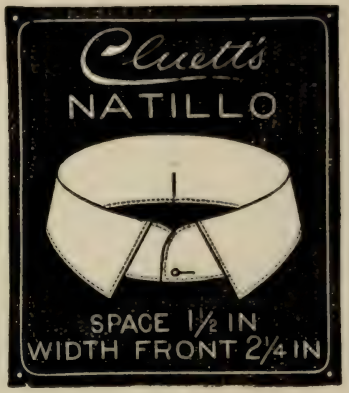

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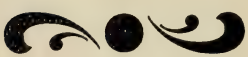

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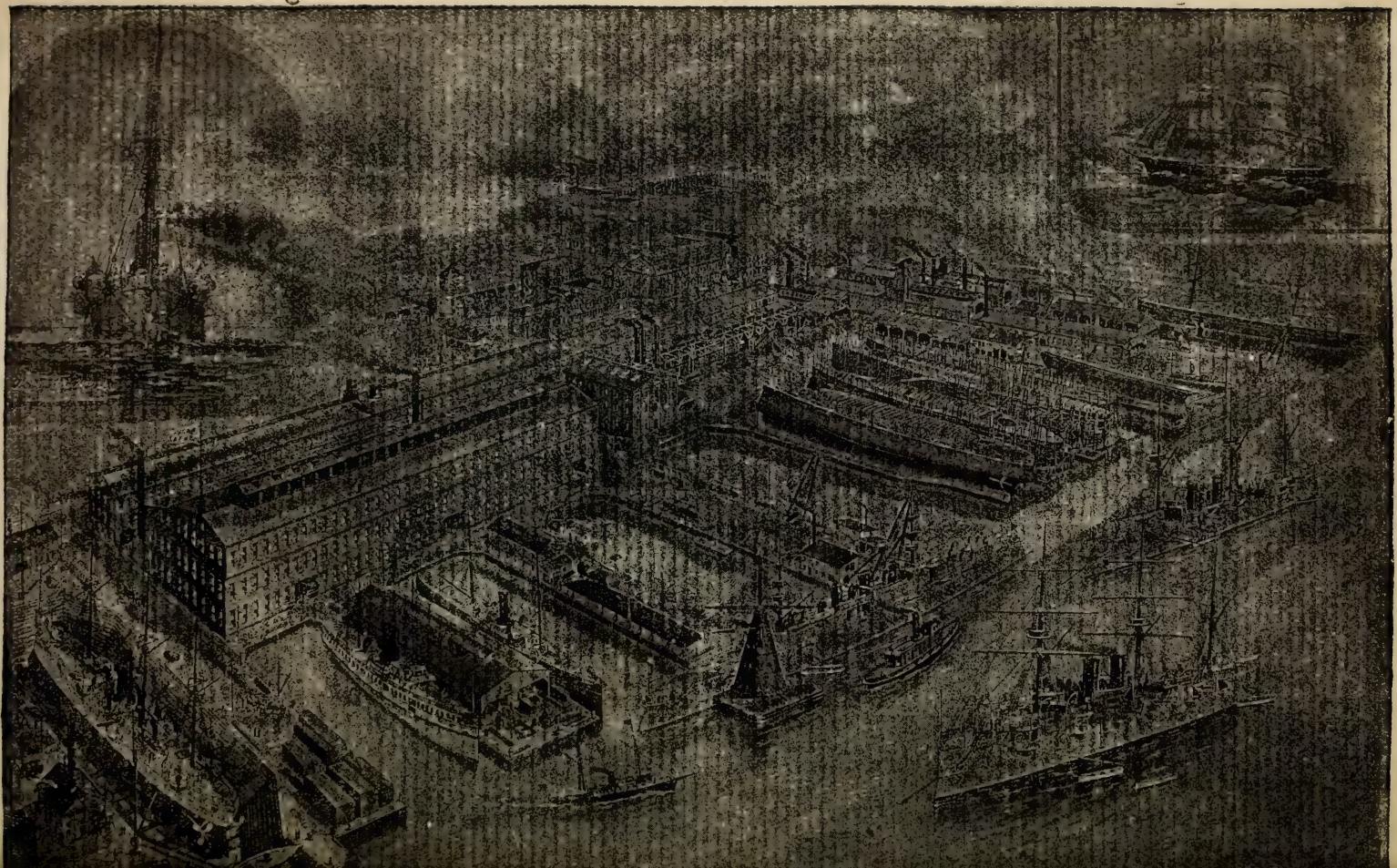

Vol. XXIII., No. 2. 1897. Whole No. 82.

PROCEEDINGS

OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XXIII.

EDITED BY H. G. DRESEL.

PUBLISHED QUARTERLY BY THE INSTITUTE.

ANNAPOLIS, MD.

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THE PROCEEDINGS

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UNITED STATES NAVAL INSTITUTE.

Vol. XXIII., No. 2. 1897. Whole No. 82.

HONORABLE MENTION, 1897.

From little spark may burst a mighty flame.—*Dante.*

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A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA.

By H. G. DOHRMAN, Associate Member U. S. Naval Institute.

The officers who have been detailed by the Navy Department to report on the efficiency of the different naval militia organizations have rendered practically an unanimous report as to the great value of this new factor in our national defense. Though in many cases there is a wide divergence of opinion as to the proper field of action for these new organizations, yet the opinion is universal among officers who have had actual experience with the naval militia, that their field is a wide and important one, and their value great enough to justify some systematic course of instruction, that the existing organizations may be made the genesis of a thoroughly practical and reliable force of trained men, to whose care may be safely intrusted the lesser problems of the naval defense of the nation.

With the variances of view of the three generally accepted schools of opinion we have nothing to do, it will be sufficient to say that the ideal organization should be capable alike of deep sea and great gun service; of the suppression of the various

local and State disorders; should possess the greatest possible knowledge of local waters and harbors, together with the means for their naval defense, and in the preparation and manning of the auxiliaries of the fleet; though it is very likely that their greatest field of usefulness may be found to be in the direction of the last named.

A careful review of the reports of all officers who have been detailed since 1892 on naval militia inspection duty shows that they unite in stating that the men of the naval militia, as a class, are readily amenable to discipline, are above the average physically and mentally, and are actuated by a high degree of patriotism and enthusiasm.

Doctors, lawyers, professors and other men of learning and distinction in civil life are found among the members; nor will this distinction as civilians be any more of a barrier to the loyal performance of their military duty, whatever or wherever it may be, than is was to the thousands of their brethren who shouldered their muskets and marched to the front in '61.

The plan of action that has been most generally approved by the officers who have given the matter any thought contemplates the thorough training of the naval militia in infantry and artillery tactics; in boat drill and general longshore work; in torpedo work and mining; in the handling of such ordnance as is best adapted to the arming of the auxiliary navy; in signaling; in the preparation of such maps, charts and topographical information in regard to their respective localities as will best facilitate the solving of the problems of coast defense; in the preparation of the necessary plans for the speedy mobilization of the auxiliary fleet, etc.

We are then, probably, practically assured of the proper scope of these organizations; but how they may be best trained and thoroughly fitted for the manifold duties that will be required of them is another, and as yet unsolved problem. It is true that the Naval War College and the Association of the Officers of the Naval Militia have done much towards systematizing the present methods of instruction, and the Navy Department towards securing uniform legislation in the various States; the wonder is that they have accomplished so much with so little to work upon.

It is practically true to-day, however, that the *exact* status of the naval militia has yet to be established and a uniform system of instruction formulated.

There exists at present in several of the States, notably Iowa, a very complete system of instruction for the use of the National Guard, and these systems are in practical and successful operation.

The manifold, complex, and, in many cases, unaccustomed duties required of the naval militia organizations require for their successful teaching to the personnel, a degree of technical knowledge and special training in their instructors that can be acquired only by actual practice, and which we cannot expect to find outside of the ranks of the officers of the regular navy.

It has been my good fortune during the past few years to have some personal knowledge of the naval militia organizations of several of the different States, and in many cases I have inquired of the members what they expected their duties to be in case of a possible war. Almost without exception there was a general vagueness and haziness of reply that betokened a woeful lack of a definite direction in their instruction. It is true that this was no fault of either officers or men, for even now the fog that has enshrouded all naval militia matters is only beginning to lift.

If the naval militia is of any value, and there seems to be no question on this point, it is certainly time that some concerted effort be made to clear up the general uncertainty and vagueness that hangs over the whole matter and give the organizations a fair chance. They cannot be expected to properly fit themselves to perform duties in the event of a possible war if they do not know beforehand what these duties are to be.

Let a board be appointed, to consist of say three officers of the regular service and two of the most experienced of the officers of the naval militia, officers who understand alike the limitations and the capabilities of their men and know just about what to expect of them.

Let this board act in conjunction with the War College. Let them carefully weigh all evidence and suggestions, and then, after due deliberation, formulate some plan of action, some systematic and adequate system of instruction that will send the men to the front, if their services are ever needed, with a clear conception of what is required of them.

It seems to me that there is only one way to accomplish this end, and that is, after some such board as that suggested has

finally settled upon a system, to establish a bureau composed of a small detail of officers of the regular service, whose duty it shall be to deliver lectures and such other practical and theoretical instructions to the various organizations as may be considered advisable. It will probably be objected by some that almost all of the younger officers of the navy are afloat and that those of advanced rank and age would not care to accept the hardships of travel incident to such service, and that therefore it would be impossible to secure such a detail; and much of this is probably correct. But if the proper training of a reserve force of 3000 or 4000 men is not of sufficient importance to secure the detail by the Government of three or four officers to properly instruct them, it is high time that the naval militia organizations were disbanded, as useless barnacles on the hull of the ship of state.

The outline of a course based upon this proposed system of instruction is appended herewith. As will be noticed, the instruction of all officers of commanding rank is preferably given at the War College, and, failing in this, under the care of an officer detailed from or under the direction of said college.

If all of our naval militia officers were millionaires, with ample leisure time at their disposal, it perhaps would not be necessary to look further into the project, for the problem would be solved.

Officers so situated could devote a summer to the course at the War College, and then be amply qualified to give all necessary instruction to the subordinates of their respective commands, for as a rule the officers of commanding rank are ex-officers of the Navy and therefore need but a little brushing up now and then to keep fully up to the requirements of the times. However, it is sad, but unfortunately true, that the commanding officers have neither unlimited time nor unlimited cash at their disposal, and generally a thorough course at the War College is an impossibility; but granting the time and the necessary cash, there still remains the further objection that the administrative and executive duties required of the commander are often of a nature to interfere seriously with the careful consideration of the problems of naval warfare, whose study would be a necessity to one who was about to act as an instructor to others.

If it were possible to fully instill into the minds of the officers commanding the mass of information necessary to make them capable instructors, and furnish them with sufficient material to

demonstrate practically, there is no reason why the very excellent plan of Iowa's School of Instruction for Officers of the National Guard could not be adopted with great profit by our naval militia organizations. However, modern naval warfare has introduced such a variety of complicated machinery, such a mass of technical detail to be mastered before one can be fully competent to instruct others, that I doubt seriously whether we have any officers in the naval militia, who have business affairs of any consequence to look after, who are competent to fulfill the requirements, able men as most of them are. They simply cannot afford to give the time necessary. As it is, many of them allow their administrative duties alone to make serious inroads upon time that should be devoted to business.

The course of instruction, as laid down in the appended chart, is intended merely as a suggestion and as showing briefly the general method proposed to be followed.

Instruction at Naval War College, or by Lecturers from Navy Department.

Captain, Commander, and Lieutenant-Commander in States having a Commander for Naval Brigade Chief.—*Course.* Practical mobilization, Naval strategy, International law, Fleet evolutions, Battle tactics and precautions, Problems of coast defense, Problems of coast defense applied to his special district, including study of transportation and supply facilities and resources, and the local topography, etc.

Instruction by Lecturers from the Navy Department.

Captain, Commander, Lieutenant-Commander, Lieutenant, Lieutenant junior grade, and Ensign.—*Course.* Maintenance of discipline, Ordnance problems, including care of the battery, direction of fire, torpedo instruction, etc., Infantry and artillery tactics, Boat and other guards, Practices and precautions of actual war, etc., Signaling, Navigation, Shore and boat exercises, Precautions to be observed in case of fire, etc., Proper provisioning and care of men on boat and shore expeditions, etc., Practical mobilization, Naval strategy, International law.

Instruction by Commissioned Officers of Division or Battalion.

Master at Arms, Boatswain's Mate, Gunner's Mate, Quartermaster, Coxswain, Bugler, Electrician.—*Course.* Infantry, artillery and boat drill, Use and care of small arms and ordnance, including direction of fire at vulnerable points of the enemy, etc., Naval ceremonies and salutes, Signaling, Familiarity with various apparatus found on shipboard, and in such other lines as may suggest themselves to the officer in charge.

Instruction by Commissioned or Petty Officers of Division or Battalion.

Seamen of the 1st class, Seamen of the 2nd class, Seamen of the 3rd class, Artificers, Yeomen, etc.—*Course.* Whatever may be considered proper by the

officer in command. Instruction in each and all of these classes shall be progressive, and promotion shall in all cases be largely governed by the proficiency attained in the various branches of study, in the relative order of their importance.

As stated before, wherever possible, it is the intention to have all officers of commanding rank, such as captains, commanders and lieutenant-commanders, take a thorough course at the War College; where this is impracticable, a special course for commanding officers will be prepared, embracing naval strategy, international law, fleet evolutions, problems of coast defense, including the problem as applied to his own special district, with enough knowledge of the general plan of defense to enable him to render efficient service beyond the immediate limits of his own district in case his services should be needed elsewhere.

It will probably be objected, and with reason, that the preparation of a special plan of defense for the individual district of each commander of the naval militia would be a tremendous and well-nigh impossible task, even with every facility at hand, and so it would be. But that is not the intention. It is not in any way the intention to prepare these plans at the War College, or elsewhere, and then say to the local commander, commit them.

It would be like memorizing the demonstration of one of Euclid's theorems and quite as productive of results. We do not want mere parrot-like learning. What we do want is to have the War College, Lecture Staff, or some other constituted authority, supply the general outline and let the details themselves be the work of the local commanders, under the direction, of course, of the above. Let them acquire such a familiarity with the resources of their respective localities and commands that if a contingency should arise that should necessitate the abandonment of all previously prepared plans of operation, that they would be prepared to think and act for themselves.

Admirable as is perfect discipline and necessary as is machine-like obedience to orders to the success of any military organization, they cannot always supply the place of brains. The mere fact of our extended coast line, our constantly increasing tendency as the years roll by to become involved in foreign complications, and the relatively insignificant size of our army and navy, point constantly to the probability that some day a foreign war will be upon us, and that heavy drafts will have to be made

upon the nation to fill up the ranks of our regiments and man the guns of our navy.

The fortunes and casualties of war will inevitably place heavy burdens and responsibilities temporarily upon the shoulders of men not now in the regular service. What these will be it is of course impossible to tell, but there is no reason to doubt that these things will happen—they cannot but help happen in war prolonged for any considerable period. We cannot expect the officers upon whose shoulders these responsibilities may fall, to give a good account of themselves unless they have been properly prepared in advance to assume the duties we have reason to believe may be required of them. They cannot inspire confidence in others if they have no confidence in themselves, and this confidence only comes with a familiarity with the subject in hand born of practice or thorough study. No man can successfully cope with the responsibilities of naval command, involving the possibilities of the attack with its attendant risks, or of retreat at an inopportune time when perhaps victory was trembling in the balance and just within his grasp, or yet of passive inactivity at a time when vigorous initiative was imperative—no man can afford to take this risk, nor can the nation afford to let him take it—unless he has, by a proper course of preliminary training, proved himself worthy.

The commanding officer should be possessed not only of a fair knowledge of naval strategy, international law, and the general problems of the defense of the coast, but his knowledge of his own particular section of it should be so comprehensive as to cover all the items covered in the General Information Circular issued by the Department for the use of the naval militia last spring, and much in addition to that. He should endeavor, wherever possible, to secure the enlistment in each of his battalions, of competent draughtsmen, civil and mechanical engineers, designers and so on, in addition to the artisans generally required by law.

By so doing, not only can he obtain excellent charts of the adjacent waters, but can secure maps giving the salient points of the local topography. Further than this, he will be enabled to secure, in many cases, the structural designs of many, if not all, of the vessels that visit his territory which are suitable for conversion into auxiliaries of the fleet.

During the long winter evenings working drawings can be made for all structural changes, deck and other bracings for gun mounts, protection of machinery, construction of magazines, etc., and should include full descriptions of all machinery, boilers, etc., found on each vessel. These plans should be made and duly numbered in the case of each vessel, in sets of four, one each for the Navy Department, office of the Adjutant General of the State, Commander of State Naval Brigade, and the commander of the local battalion, where the organization of the brigade and the battalion is not identical, in which case the extra set of plans should be filed at the Navy Department. Examination of the vessels and the condition of their machinery should be made at least yearly, and such reports are to be made in the same number and manner as the plans, and should be filed with the said plans, at each of their several places of keeping.

Under the head of each vessel, in addition to the number of guns she can mount, bunker and magazine capacity, etc., should be entered the number and names of each harbor she can safely enter in the district; where coal in sufficient quantities can be obtained (the character of the coal as to steaming qualities, etc., should be noted in addition); what the loading facilities are in each place so mentioned, and the average time required to fill bunkers; the number of establishments capable of making repairs to hull, boilers and machinery—the character of such repairs and probable time required to complete same; the facilities offered for obtaining provisions and other ship supplies, including an estimate for the time required to install battery, supply magazine, provision ship, etc., ready for active service. All this and such other information as is obtainable in relation to the individual ship should be entered in two small duplicate books, said books to be filed with the Navy Department. The books should be marked with the number of the ship, which in every case should be known by number only, until such time as the mobilization of our auxiliary fleet would be required, when one copy should be forwarded to the ship's commander, who will cause same to be placed with the ship's private signal book and treated accordingly.

That the full value of this system be brought out, the whole of the nation's coast line should be apportioned into as many divisions as there are States having either sea or lake frontage,

this being done to facilitate the work of the different State naval militia organizations now in existence and of those that are yet to be authorized.

Each State in turn is to be subdivided into sections of, say, 25 miles each, the State being considered as a unit containing so many sections of the standard size.

That there may be no confusion arising from the duplication of numbers in so many different States, each section shall bear a number and be known by it regardless of the State in which the section is found. For instance, let us take the most eastern portion of the coast of Maine as a starting point. Measuring towards the west, we follow the line of the shore for 25 miles, which constitutes section one, the second 25 miles so measured in the same direction constitutes section two, and so on until the complete round of the water-bearing frontier of the nation is completed.

Roughly speaking, the coast of the State of Maine would be known as sections 1 to 14, constituting Division of Maine; that of New Hampshire as sections 15 to 17, constituting Division of New Hampshire; that of Massachusetts as sections 18 to 20, constituting Division of Massachusetts, and so on, until the round is completed. Texas might be known as sections 158 to 181, constituting Division of Texas, and Indiana as sections 200 to 204, constituting Lake Division of Indiana, prefixing Lake to such divisions as lie along the borders of our great lakes, to distinguish them from their salt water brethren.

A section or more would be assigned as the year's work of each division of a battalion, but this allotment should never be arbitrarily fixed, but, on the contrary, should be governed entirely by the difficulty of the task.

Some sections could be thoroughly covered and all needed information secured in a few days' time, while others again would require the work of months. It is understood, of course, that the sections would not be studied consecutively, but in the order of their relative value, great centers of trade and important strategic points being naturally considered first.

However, it is beyond doubt that if this system be properly adopted and its details systematically and carefully followed out, that it will furnish us with practically all the detailed information necessary for the solution of many of the problems presented by

the naval defense of our coasts, in a half-score of years or less, or at least so much of the necessary information as can be obtained by the careful study of the coast line, and is within the scope of a purely volunteer organization, with limited opportunities for actual service in many cases.

To what extent the Navy Department has recognized the value in this line of work of the Naval Militia is shown by the following extract from Secretary Herbert's report for 1895:

"The information collected by the first battalion of the Naval Militia of New York during the past summer relative to the shore line of Long Island is of such value that the Department unhesitatingly indorses the proposition to engage this corps in the study of our entire coast line. Every battalion, with proper help and direction from the Department, can, as shown by the admirable work done on Long Island Sound last summer, acquire information as to its contiguous coast that would be invaluable in case of invasion."

That the Department has recognized the value of the naval militia sufficiently to consider some uniform plan of instruction will be seen from the following from Secretary Herbert's report for 1896: "To more thoroughly instruct the Naval Militia in the duties which will be required of them in case of mobilization or of war, it is the intention of the Department to communicate to them as soon as practicable that portion of the plan of general mobilization and defense which relates to the several States to which they belong, what vessels are to be used, what positions not embraced in the military defense must be mined and protected by batteries, what signal stations must be maintained, and, in general, everything that must be done to utilize all possible resources for the local defense.

"This will be the work of years, but it is believed that by intelligent co-operation between the officers of the Department and the Naval Militia, a thoroughly digested plan of mobilization and subsequent operations may be gradually effected, which will be of inestimable value to the country."

With this in view, the Department granted permission to the officers of the Naval Militia to attend the War College and Torpedo School. Six officers followed a portion of the War College course and nineteen were instructed at the Torpedo Station during the past summer, but the very considerable expense

attached to this service obviously renders impossible the attendance of many worthy officers who are so unfortunate as to reside at a great distance from Newport.

To successfully inaugurate a system of instruction by a traveling corps of lecturers would not, I feel confident, necessitate the detail of more than four officers from their regular duties, to cover the whole of the country, including the Pacific Coast States. If the Pacific slope and possibly Texas are omitted, two officers on a properly arranged schedule can deliver four lectures apiece at each battalion headquarters within the district named during the eight months from October 1st to June 1st. This will give one lecture a month at each point, the lecturers alternating.

The proper preparation for these lectures can be arranged for by the creation of a number of small but select traveling libraries, equal in number to the points at which lectures will be delivered during the course. The libraries will be loaned by the Government to the different organizations and retained by them until the completion of the course for the year.

The composition of these libraries should be decided upon by the War College at the time of the determination of the proposed course for the current year, and should consist of such works as will enable the officers of the Naval Militia to make proper preparation prior to the delivery of each lecture. Each officer, where practicable, should be furnished with a synopsis of every lecture at least ten days prior to its delivery, and said synopsis should contain a list of the authorities to be consulted, as many of which should be embodied in the traveling library as possible, ever bearing in mind the fact that the consultation of multitudinous references is confusing to the lay reader, and for this reason the library should be very compact, containing nothing but the essential authorities on the subject-matter in hand.

Such a course of eight lectures might be made up as follows: one lecture on the general principles of naval warfare; one lecture on international law; one lecture on conduct of landing parties and general shore operations; one lecture on signaling, seeking, if possible, to secure a practical knowledge of both the army and navy codes, that the Naval Militia might act as an efficient intermediary in case of need; two lectures on the problems of mobilization, and two lectures on torpedoing and mining, illustrated by working models of reduced size, if possible.

The mere fact that promotion should be made largely dependent upon the proficiency in the various branches in the relative order of their importance would act as a powerful incentive to close application, if there were no other reasons.

It seems to me that the thorough consideration and study of such courses as this each year cannot help but largely increase the effectiveness of the Naval Militia, and when we stop a moment to think and realize the heavy burdens that must of necessity fall upon the shoulders of these men in case of a war with a first-rate naval power, we should consider very carefully before rejecting any suggestion that tends to increase the efficiency of our naval defenses.

Nowhere is the importance of the early and systematic training of the Naval Militia of more moment than in any consideration of the defense of our great lakes and in the conduct of any military operations directed against the Dominion of Canada. It is patent to any one that the construction of the various canals passing through territory under Canadian control by which vessels from the Atlantic can have untrammeled entrance to the lakes, has practically nullified, so far as Great Britain is concerned, the provisions of the well known treaty of 1817. Great as is the excess of American tonnage on the bosom of the lakes, it will be a source of weakness rather than of strength, if we are not prepared at an instant's notice to convert our peaceful merchantmen into powerfully armed and thoroughly equipped cruisers of the auxiliary fleet, capable of blockading the Canadian canals and preventing thereby the entrance into the lakes of the British squadron; or at least capable of rendering a good account of themselves in any conflicts that might occur for the supremacy. A summer's campaign in Canada would be practically impossible without the control of the lakes by our navy, and the hordes of men that are prepared at a week's notice to overrun Canada, that we hear of so often during the periodical twistings of the British Lion's tail by our zealous jingoists, we fear would suffer an unpleasant awakening from their pleasant dreams of easy conquest and cheaply won glory.

It is true that joy over the probable conclusion of a five years treaty of arbitration between the two great English-speaking nations of the world is echoing and re-echoing over England and America at this Christmastide, and far as it is from any true

lover and well-wisher of either nation to wish for anything else than the early consummation of a bond of amity between the two nations that shall forever render war between them a thing improbable if not actually impossible.

Yet we would be blind to the dictates of military prudence if we did not carefully consider the possibility of the proper defense of the nation against attacks from every quarter, regardless of present state of existing friendships. The great preponderance of the naval power of Great Britain, our long and unprotected Canadian frontier, including the defenseless cities of the great lakes, render the consideration of the possibility of attack from this direction of the most vital importance, and into any intelligent consideration of this problem, the part to be taken by the Naval Militia of the lakes is bound to be a factor of great importance.

When so much may depend on the efficiency of the Naval Militia organizations, is it not the part of prudence and wisdom to afford them every possible aid in their efforts to properly fit themselves to assist in the defense of the nation?

DISCUSSION.

Lieut.-Commander RICHARD WAINWRIGHT, U. S. N.—I have read the paper of Mr. Dohrman with great interest, and agree with him thoroughly as to the value of the naval militia organizations and the necessity for a systematic course of instruction and training.

As Mr. Dohrman states, there appears to be a wide divergence of opinion as to the proper field of action for the naval militia, and this has led not only to some uncertainty as to the proper course of training, but also served to somewhat discourage the organization. In order that the officers and men should take real interest in their work the course of instruction must be made interesting, and, above all, they must see plainly before them the useful results intended to be reached by the work. They are patriotic, and desire to see some real position of value to be occupied by them in time of war, at which their training in time of peace has been directly aimed.

The navy has no reserve *personnel* unless the naval militia is trained so as to form such reserve. All the great naval powers have large reserves upon which they can draw when it becomes necessary to mobilize their fleets. At the present time this difficulty is avoided by us, as we keep all our ships in active service; but it is manifest that this cannot continue when we have a number of vessels more nearly adequate to the needs of

the country. Then a proportion of the vessels must be placed in reserve, with small crews sufficient to keep the vessels in every way ready for immediate service. But vessels in reserve will be useless without men in reserve, for modern men-of-war require well-trained men to handle them efficiently. To furnish this reserve is, in my opinion, the most important field of action for the naval militia, and the one that they can fill most efficiently with the training possible under the conditions of their organization.

The naval militia can be trained, if reasonable facilities are offered, in the use of modern guns and how to care for them. Much of their training can be carried out ashore, so that with some little training afloat both officers and men can become competent to man the batteries of our war-ships. With a proportion of our ships in reserve, there should be a sufficient number of men to fully man the armored fleet and some of the larger cruisers and to furnish a nucleus of a crew for the remaining cruisers. To each of these cruisers a certain number of naval militia should be assigned sufficient to man all the guns, leaving the different organizations intact as far as possible. The regular crew would perform all the special seaman's duties and handle the engines, etc. When it is desirable to exercise any portion of the naval militia it should be done on the cruiser to which it is assigned. If this cruiser is in the active fleet, its shifting crew should be sent to the corresponding vessel in the reserve. If it is in reserve, it would only be necessary to march the naval militia organization on board, fill up the fire-room force and go to sea.

The next most important field that can be occupied by the naval militia in time of war is that of manning the batteries of such auxiliary cruisers as may be armed by the government. For this the same training is needed as for manning the guns of the regular cruisers.

Beyond doubt there are many other duties that may be performed in time of war by the naval militia organizations, requiring other kinds of training, some of which may prove more amusing if not as useful. There are many duties that might be pointed out pertaining to purely local defense and longshore work, some of which are pointed out by Mr. Dohrman; but such duties should be left to those organizations that are unwilling to leave their own ports or that join the organization for amusement. I much mistake the spirit that animates the present organizations which form our naval militia if they have many such men in their ranks. I believe that as a body they have formed and joined these organizations with the patriotic motive of serving their country in time of war in such positions as will be most useful. All that they require is that the proper field of action, and the training necessary to fill it properly, be pointed out to them and that it is a dignified and naval position.

Courses in strategy, tactics, coast defense, international law and navigation may all prove interesting and can do little harm if they are taken up purely as a mental stimulus without neglecting to occupy the time necessary to acquire a good knowledge of naval ordnance and gunnery. It is possible for those whose life work is in a profession or trade on

shore to become good gunnery officers or good gunners by systematic training. But it is impossible for them to become even tolerable seamen or navigators, or to acquire the skill necessary to handle a modern warship, much less to handle a fleet. Infantry drill is good discipline; some signaling knowledge would be advantageous; but the main study of the naval militia should be gunnery, and their principal exercise should be with the great guns.

While I have differed broadly from the ideas set forth by Mr. Dohrman, I believe we both have the same object, that is, to point out the honorable and useful position that should be filled in time of war by the naval militia, and the systematic course of training necessary to fit the organizations to fill this position.

There will always be many functions that can be performed in time of war by auxiliaries to the regular naval force, unless we should be more thoroughly prepared for war than seems at all likely, and some field of usefulness would be found for an organization however trained; but the most useful, the most honorable and worthy of the combined efforts of the naval militia is that of trained gunners.

Col. J. L. Carter, Assistant Inspector-General, State of Massachusetts.—It is a very gratifying sensation to feel that there are intelligent minds studying the subject of the national defense, and in no quarter is there more room for study than in the problem of the functions and scope of the new branch of our service, the naval militia. The paper under discussion—"A proposed uniform course of instruction for the naval militia"—by H. G. Dohrman, is a valuable contribution to the growing literature on this subject, and while I do not concur fully in all of the propositions which it contains, I find a great deal which is valuable and which should receive serious consideration by those to whom the operations of the naval militia are committed.

I believe that there should be a board detailed, as the paper suggests, to formulate a system of instruction and a plan of action, and that the work so formulated should be limited to the simplest possible duties consistent with proper effectiveness, because the time at the disposal of both the officers and enlisted men of the militia is very brief.

There is, I fear, too great a tendency to spend valuable summer-time work in taking down small details of coast topography which are amply covered now by the coast survey charts. Certain data are needed, it is true, connected with strategic plans, and what these are can be best determined by the Naval War College, whose calls for information should be forwarded by the Navy Department to such of the naval militia organizations as are best situated to furnish them. To this extent I concur with the essayist in his recommendation about a study of the coast.

The plan of keeping informed about the available merchant vessels for hasty conversion into armed auxiliaries I heartily endorse. In fact, I believe the manning of these vessels, especially as to their armament, is one of the duties which will be most urgently demanded of the naval militia in case of war. There are plenty of seamen in civil life who can

volunteer and man these vessels, but they would not know gunnery and could not be taught to handle the modern breech-loading rifle guns soon enough to be of use. Modern wars come quickly, and the fire burns briskly while it lasts. There is no time to teach gunnery, so let that be learned in time of peace by the naval militia, and have the men and the guns ready to place quickly aboard of our fine coastwise merchant steamers.

The suggestion that lectures be delivered by officers detailed for the purpose, though good in theory, would, I think, be of little benefit in practice. Lectures go in at one ear and out at the other, unless, as at college, one is studying text-books on the subject under treatment and is attending a systematic course throughout a whole season.

The written lectures put into print and distributed would be valuable. The more literature we have on this subject the better; there may be much chaff, but there will also be many rich kernels of grain when the winnowing is done, as the paper now under discussion shows.

Lieut. J. H. Gibbons, U. S. N.—With the principal proposition laid down by the essayist, viz. that the naval militia must be an important factor in our national defense, and that it stands in sore need of a systematic course of instruction, every one can agree. When it comes, however, to the question of the best means to this very desirable end, the essayist seemingly ignores the "spark" and battles with the "mighty flame" of his motto.

A glance at his proposed course of instruction on page 215, especially that for commanding officers, will convince any naval officer that the ground to be gone over would take much more time than business and professional men would be able to give to such work. If a naval officer wished to become a lawyer he would not qualify by simply attending sessions of the Supreme Court. The statement that ex-officers need but a little "brushing up" to keep fully abreast of the requirements of the times will not, I am sure, be borne out by the testimony of those for whom the claim is made. I quote from the remarks of the commander of the Massachusetts Naval Militia:—"We have found that there are limits to the work that a business man can put in, in a military sense. . . . We have been asked the question, What do you think you are for? . . . There must be a naval militia and a naval reserve, and the navy must look to the naval militia as its reserve and as a second line of defense. . . . I am not in favor myself of going on board ships which would go to sea for fighting purposes."

The Naval War College has also marked out the province of the naval militia. "The wars for which we must plan, at least for the next few years, are defensive on our part and to be waged against enemies probably superior to us on the sea. This throws upon us, as a principal rôle, the defense of our coast and the supplementing of our small sea-going navy by a formidable flotilla of small craft, which, when thoroughly organized and drilled, shall dominate our channels, sounds and bays, and make their comfortable or permanent occupation by hostile fleets an

impossibility." (Letter from the president of the War College upon the subject of the naval militia.)

Dismissing then the idea that the naval militia may be depended upon to supply the navy with deep-sea sailors, and granting that its true field is the line of inner defense, the problem of systematic instruction is greatly simplified. Discipline cannot be taught by traveling lecturers; efficient organizers are born, not made. These small beginnings must not be overlooked in the vague longing to tackle some "tremendous and well-nigh impossible task." To produce a well-drilled boat's crew does not need a knowledge of "international law," and if instead of wrestling with "fleet evolutions," "battle tactics" and "naval strategy," attention is given to such primary subjects as handling cutters under oars and sail, heaving the lead, boxing the compass, knotting and splicing, small-arm and boat-gun target practice, etc., the result will be a certain alertness, handiness and self-reliance that will enable the militiaman to be a useful factor when the government calls for his services. For the "habit of the sea," upon which the naval authorities of all nations lay so much stress, should be substituted "the habit of the harbors, rivers and inland waters." Too much credit cannot be given to the naval militia of New York for their work in this direction, and at the same time it must be borne in mind that the initiative came from the State.

Expedients and devices for keeping the men interested in their work make the duties of naval militia officers very onerous. In this the navy cannot be of any material aid; it is a local issue. The plan of having an annual meeting of naval militia officers from the several States, where they can discuss matters of interest to them, bids fair to give excellent results. When the States can agree among themselves as to what they consider their most crying needs, it will be time for the navy to pass judgment. They still seem to be far apart on such questions as uniform, organization, and federal relations, but are practically unanimous as to what their relations to the State should be. The navy can only suggest; it has no authority in the premises. Encouragement always comes from an expression of good-will and sympathy. This has been freely given, and while a process of coercion might in some cases be beneficial, it would surely result in the formation of a Society for the Prevention of Cruelty to the Naval Militia.

The War College has indicated the general lines on which the naval militia ought to expand. The initiative must come from the several States, and the commander that can keep his men on these lines will render the best service to the general government; at the same time, however, he must satisfy his own particular State that his work is also in their interests, and he must be able to so direct the efforts of his men that serious work takes the guise of a diversion. That there are such commanders, experience has already proved. There is no royal road to the naval profession, and the naval militia must be content with its minor phases so long as the commercial spirit of the age forbids, on economical grounds, any large number of our citizens giving a great amount of time to what Captain Mahan calls *preparedness* for war. The enrolling, under

national auspices, of a true naval *reserve* made up from the seafaring classes should be the next step in the organization of a volunteer naval force, but this can hardly be accomplished until legislative stimulation revives our deep-sea merchant shipping.

Lieut. A. P. NIBLACK, U. S. N.—Mr. Dohrman has been practically the pioneer of the naval militia movement in the Middle West. To his energy and interest the present organization in Ohio is largely due. It is through such patriotic citizens that we can hope to make our readiness for war bear some trifling proportion to our confidence as a nation in our invincibility. The narrow spirit present in all military organizations has given way in our small navy to a cordial recognition of the possibilities of the naval militia. If they have done nothing else, the members of the naval militia organizations have helped us in Congress and with the people. But they have done something else. They have helped stir up the navy itself to a large and broader conception of its own possibilities. That admirable organization, the Naval War College, has been the first to seize upon and utilize the naval militia as an auxiliary to its great work in the preparation for the national defense. As to what shall be the direction the general training of the naval militia shall take that should no longer be an open question. There is danger of making it too diffuse. As the Hon. Wm. McAdoo has often said, "There are so many fields of usefulness for the naval militia in case of war that the difficulty would not be to find work for them, but to select among the many that in which they could serve the country best."

Being State organizations, local laws often limit the field of expansion of the naval militia, but the Navy Department has in the past endeavored to study local conditions in helping the naval militia, but has avoided direct suggestion. As a matter of fact, they want and appreciate direct suggestions.

The present administration is not likely to prove wanting in "directive force," and as the naval militia has arrived at a point where it needs it just now, the movement in general will likely receive a new impulse. Mr. Dohrman's suggestions merit careful consideration in any definite scheme. The navy, the Naval Institute and the naval militia all owe him much for his valuable services.

(*Discussion continued on page 357.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE COMPOSITION AND ARRANGEMENT OF SHIPS' BATTERIES.*

By P. R. Alger, Professor of Mathematics, U. S. Navy.

One of the most interesting and important ordnance questions to-day is the determination of the character and disposition of battery most advantageous for the various classes of ships of war.

In the matter of gun construction, progress for some years has been only in the perfecting of details. The breech-loading rifle, built up of forged steel parts, or wire-wrapped, is not likely to be superseded by any other weapon. Improvements in quality of materials may enable us to make guns lighter, and new methods of construction may enable us to make them cheaper, but no radical changes are likely to be made, and it is the perfecting of such details as the firing mechanism and sights that now principally occupies the attention of the ordnance officer.

Gun mountings, too, have been improved to the point where but little further advance seems possible. The balanced gun mount, with hydraulic recoil check and spring return, leaves little to be desired.

As far as ammunition is concerned, great progress has been made in increasing the efficiency of projectiles and fuses, and further progress is being made all the time, but this progress consists in the improvement of what we have, not in the invention of new things. The introduction of the so-called smokeless powders was, indeed, a radical change, putting at the service of artillery the most powerful explosives known, but another similar step in advance can only result from the discovery of an entirely different type of explosive from any now known to chemists.

* Lecture delivered before the Naval War College.

The very fact that all civilized nations use practically the same guns, mounts, projectiles, powder, etc., is a sufficient guarantee that our ordnance material is constructed upon principles of sound reason.

When, however, we consider the composition and disposition of ships' batteries, we find not only the greatest divergence in the practice of different nations, but radically different views adopted in the various designs of each particular navy. It would appear beyond doubt that for every special type of war-ship one particular battery is best suited, and that a little study of the uses to which a given type is adapted, and of the purpose for which the type was developed, would result in at least tolerable unanimity of opinion as to the most efficient armament for that type. The trouble has been that this matter has received of late years too little attention, and its determination has been too much in the hands of people whose interests are enlisted in the development of other features of ship design. The reputation of a ship designer and the profit of a shipbuilder are not affected by her greater or less efficiency as a fighting machine to the same extent as they are by her greater or less speed. The faster a ship, the more widely advertised to the world are her designer and builder; the greater the percentage of displacement allotted to hull and machinery and fittings, the larger the margin of profit on the contract. The wide-spread craze for fast unarmored ships was, in my opinion, born of the personal interests of shipbuilders, and has lived, and even flourished, largely because the military branch of naval service has been excluded from its proper predominating place in the councils which determine the general features of ships of war.

Let it once be recognized that the object of a man-of-war is to win battles, and that battles are won by fighting, not by running, and more regard will be paid to the selection and arrangement of weapons, and the less will offensive power be sacrificed to speed. I have never been able to see what material advantage the commanding officer of a ship would derive from her possession of greater speed than an adversary, nor am I inclined to believe that the commander-in-chief of a fleet will be able to use to any great advantage the high speed of his vessels in an action. Of course, speed is useful as a means of escaping or forcing an engagement, and as giving the power of rapid concentration or

of striking suddenly at a distant object; but when the moment of actual fighting arrives, superiority of speed will weigh as nothing in comparison with superior armament. In the consideration of this subject, moreover, one point has generally been overlooked, and that is, that in many, if not all, modern fast cruisers there is not berthing space for a crew sufficient in numbers to maintain both speed and rate of fire at their highest during an engagement. If sufficient engineer force is employed to keep steaming power at the top notch, the fire of the guns will inevitably slacken at the first serious casualty or from the fatigue of the first few moments of action, relief crews being wanting. The popular idea seems to be that the battle may be won by simply rushing about at tremendous speed, but I think any sensible man would prefer slowing down to slackening his fire.

In the days when sea fighting was the frequent occupation of the naval officer, ships were designed for fighting purposes and everything else gave way to the guns, for experience had taught the lesson that they were what won the battles; too frequently in the recent past a ship's armament has been considered rather in the light of an accessory, to be determined at the convenience of the designer after other requirements have been met. But the experience of the past should be our present guide, and if interpreted with common sense, will lead us to sound and reliable conclusions. The test of war is *not* necessary to decide the relative value of different designs of modern war-ships. If we refuse to be led blindly by authority and rely upon the dictates of common sense in determining the general features of our designs, we cannot go far astray.

The criterion by which *every* war-ship can be rightly judged is the answer to the question, "To what specific use will this ship be put in war time, and is she well adapted to that use?"

The apparent economy resulting from building vessels essentially adapted to the peace duties of a navy is out of all proportion to the depreciation in value of such material in time of war, for which a navy essentially exists, and true ultimate economy consists in building for war purposes only.

Now while there are certain subordinate purposes for which ships of war are needed, I conceive that their principal and fundamental object is to fight other ships of war. Moreover, any given class of ships will naturally be employed in the same general way in our own and in a hostile navy.

Consequently, for whatever specific end a ship is built, it is essential that she shall be so armed as to be able to meet on equal terms a similar ship of equal size. In other words, a certain percentage of the displacement of every ship, the amount depending on her type, should be allotted to her battery, and the character of that battery should be such as to be most effective against an opposing vessel of the same type.

When, for example, we consider the uses to which unarmored cruisers would be put in war time, we find that they can be summed up under four heads: 1. To destroy the enemy's commerce and supply-ships; 2. to convoy and protect our own commerce and supply-ships; 3. to act as adjuncts to the battle-ships, keeping touch with the enemy, giving information as to his movements, and engaging his lighter vessels as opportunity offers; 4. to assist in blockading the enemy's ports.

But in each of these employments they must come in contact with similar ships of the enemy's fleet; if we employ cruisers to attack the enemy's merchant marine, he will employ cruisers to convoy and protect them, and *vice versa*. If he can afford to convoy with battle-ships or to obstruct a trade route with armored cruisers, we must likewise attack and defend commerce with armored ships. On the whole, I do not see how a better rule can be laid down than that every war-ship should be designed for the specific purpose of meeting and whipping any hostile ship of the same class and size.

Of course, a logical deduction from this rule is that the type of ship should be determined by her displacement. Every ship above a certain size should be partially armored, and every ship of a still larger size should be a battle-ship, and this conclusion I personally accept as correct, although it is contrary to universal practice.

Exclusive of torpedo vessels, I would have only three classes of war-ships—unarmored cruisers of moderate displacement, battle-ships of the greatest displacement allowable, and armored cruisers between the other two. Then, as it used to be in the old days, the fighting force would be proportional to the displacement, and none of our ships would have to ignominiously flee from an enemy of equal size. If we build ships to fight, it would certainly seem reasonable to require their cost to be a measure of their fighting value; and I believe that war vessels should be built

for this purpose primarily, not for running after mail steamers or running away from an enemy. Let us then, in the light of the foregoing rule, consider what composition and arrangement of battery is best suited to the various types of ship.

But to do this we must first formulate a method of measuring the relative efficiencies of batteries. What are the factors whose product is a true measure of the value of a given arrangement of guns on any ship when used against an opposing vessel of given characteristics? The value of any one gun is proportional to, 1st, its projectile weight; 2nd, its rate of fire; 3rd, its arc of train; 4th, the area of the opposing ship against which it is effective; and 5th, the importance of the parts of the opposing ship against which it is effective, and their position. In reality, the "weight of projectile" should enter into the formula to a slightly higher power than unity, and in not so using it we are underestimating the value of caliber. This, because the chances of hitting with the big shell are greater than with the small one. The accuracy of modern guns is practically the same for all calibers, and so is the muzzle velocity, but the large projectile loses velocity more slowly, and consequently has a flatter trajectory than the small one. However, to say that the value of a gun is proportional to the weight of its projectile, other things being equal, is near enough to the truth for all practical purposes.

In making the value of a gun proportional to its arc of train, again we are not strictly correct. In the very nature of things an enemy will be more often on one side than ahead or astern, and consequently a gun training over the 90° from bow to quarter is much more valuable than the same gun so placed as to only cover the 90° from one bow to the other or from one quarter to the other. It happens, however, that the form of a ship's deck makes it necessary, if a number of guns are carried, to mount most of them in broadside. The only practicable head fire must come from such guns as can be mounted at the extreme forward end of the battery, and the only practicable stern fire must come from guns similarly situated at the after end.

The fact that a ship is eight or ten times as long as she is broad, and that you cannot without great sacrifices have more than two tiers of guns, makes it inevitable that broadside fire should predominate. Consequently, while in assuming all arcs of train of equal extent to be of equal value we commit an error,

this is compensated for by the fact that the guns with the least valuable arcs of train, ahead and astern, are few in number and are therefore of increased value, because if removed they would leave the ship with no offensive power in those directions. In other words, although heavy head or stern fire is less important than heavy broadside fire, still some head and stern fire is very desirable.

As to the 4th and 5th factors—area of enemy against which effective, and importance and position of that area—these are frequently not taken into account, and yet are of almost determining value. Evidently, if your gun cannot penetrate any portion of your enemy it is absolutely valueless, whereas if it be effective against the entire area of the enemy it has the maximum possible value as far as its chance of doing harm is concerned.

Again, if only effective against unimportant parts of the enemy, evidently a gun has small value as compared with one which can pierce her vital parts. Finally, the distribution of the vulnerable parts is of importance. If the area which a gun is effective against is composed of several smaller areas widely separated, that gun is of less value than if it were effective against an equal area all at the center of the enemy, because in the latter case the chance of hitting a vulnerable part is the greater. Consequently, in assigning value to a gun we must use a numerical factor depending entirely upon the character of the opposing target, and measuring not only the area against which the gun is effective, but the importance and distribution of that area.

Having thus decided as to the method of measuring the value of a single gun, the next step is to determine the value of a number of such guns arranged in a given manner. Of course, if each gun trained over exactly the same arc, both as to extent and position, then n guns would have n times the value of one gun. But suppose, to present the problem in concrete form, we have two guns so arranged that both fire over the same 180° from right ahead to right astern on one side, would this arrangement be better or worse than having one gun on each side each with 180° train? In the first case you could bring two guns to bear as long as the enemy was on one side, and would have no offensive power against an enemy on the other side. In the second case you could always bring one gun to bear on an enemy, but never two.

For my own part I should prefer the concentration of fire over a limited arc in a single ship action, and all-around fire at the expense of power in a fleet action; but it seems probable that in the long run the advantages and disadvantages of the two arrangements would about balance. Consequently I conclude that the measure of the value of any given battery may be arrived at by taking for each gun in the battery the product of its weight of projectile, rate of fire, arc of train, and a numerical factor depending on the character of the target, and adding these products together, which may be summed up by saying, the best battery is the one which gives the greatest volume of effective fire over the largest arc. And it is the qualifying word *effective* in this statement which clearly shows how necessary it is to know the character of her probable adversaries before we can properly assign the battery to any given ship. Measured as above, the most efficient battery for use against a battle-ship will be seen to be very inefficient against an unarmored cruiser, and *vice versa.*

Beginning then with the unarmored cruiser class, let us see what is the most effective battery which such a ship can carry. First, as to caliber, since the weight of the projectile is proportional to that of the gun, and since rapidity of fire increases with decrease in size, it is evident that the smaller the caliber the greater the weight of the projectiles fired in a given time by guns of a given aggregate weight. In other words, 100 tons of 6-pdr. guns will fire several times the weight of projectiles per minute that 100 tons of 5-inch guns will, which would lead us to the adoption for the batteries of unarmored ships of the smallest rapid-fire gun which is effective against similar ships at fighting ranges, were it not for the fact that neither space enough nor crew enough are available for the number of very small guns which can be carried on the weight allotted for the battery of the average unarmored ship. The 14-pdr. is about the smallest gun which can be considered as effective against an unarmored ship at 2000 yards range, and if the entire ordnance weights of the Chicago, for example, were given up to 14-pdr. guns and ammunition, she would carry about 120 of these guns, and the weight of metal thrown per minute by such a battery would greatly exceed that thrown by an equal weight of larger guns. But it would be impossible to find emplacements for so many guns or to carry the crew for their proper handling. Conse-

quently we are forced to go to a higher caliber, and practically we find that maximum effect is given by a battery of the largest guns to which the rapid-fire principle can be applied. This I take to be the 5-inch caliber, the fixed ammunition of which, weighing 95 pounds, is about as much as one man can handle readily at sea. I would have, then, the batteries of all unarmored ships composed exclusively of 5-inch rapid-fire guns, except where the small displacement limited the number of guns too much, in which case the 4-inch gun should be used. Against an unarmored ship such a battery will give the maximum volume of effective fire.

The next question is, what is the best arrangement of such a battery, and it is evident at once that if a considerable number of guns are to be carried they must be in broadside. Of course the mounting of spar deck guns on the center line has the same advantages on unarmored as on armored ships, but it is seldom practicable to do this with small guns—only in the extreme bow and stern of the ordinary cruiser can a 5-inch gun be so mounted as to fire on both sides. If but a few guns are to be carried, they can be put in separate compartments and widely separated; but this, in my opinion, is undesirable. Not only is control of the battery rendered very difficult, but the number of casualties will be increased, owing to the multiplication of bulkheads. But above all, the arrangement of the guns in broadside on one or more decks, clear fore and aft as much as possible, is absolutely necessary in order to carry enough guns to give the great volume of fire which is so desirable.

The best possible defensive position as well as the best possible offensive position for an unarmored ship is with the enemy off the broadside, and the whole aim and object of the commanding officer of such a vessel in action should be to keep in that position. The chance of being hit is then the least, the effect of a shell entering and exploding is the least, and the maximum number of guns are brought to bear.

As an example of what may be done on a moderate displacement, let us take the Chicago and compare her present battery with one which might replace it. The Chicago is now armed with four 8-inch, eight 6-inch and two 5-inch guns, besides a secondary battery. These can be replaced without increase of weight by 30 5-inch rapid-fire guns with 50 rounds of ammuni-

tion each, or if we do away with the secondary battery we can have 70 rounds each. It would seem to many unwise to have no secondary battery guns on a ship, but with a very large number of rapid-fire guns bearing on all points I am inclined to think that a better defense against torpedo-boat attack can be obtained by the use of canister from the larger rapid-fire guns than by the shell-fire of the smaller calibers. Can any one doubt on which side the advantage would lie in an action between two Chicagos, one with her present battery, the other with 30 5-inch rapid-fire guns?

It may very properly be said that 70 rounds per gun is an inadequate supply of ammunition, but this is due to the large percentage of the Chicago's displacement used for machinery and boilers. The new weights for the Chicago are 182 tons less than the old ones, and she is to have three knots more speed. Moreover, a saving of about 40 tons more is to be effected by removing her spars and rigging. Of the total saving, 87 tons is to be used for an additional coal supply, but the remaining 135 tons would give 100 rounds more per gun if allotted to ordnance. With a battery of 30 5-inch rapid-fire guns, and with 170 rounds of ammunition per gun, the new Chicago would seem likely to be at least a fair match for any unarmored ship afloat.

In criticising the batteries of unarmored ships it is only fair to remark that the rapid-fire gun of large caliber is a development of the past few years, and smokeless powder, which will so greatly add to the effectiveness of rapid fire, is but now coming into service use.

The possible batteries of the heavy armored ships, which constitute the real fighting force of navies, on the other hand, are much the same to-day as they were when armored ships began to be built and the turret was invented. For twenty-five years the usual and only reasonable arrangement has been two or more heavy guns in turrets and a number of smaller guns wherever places could be found for them. The progress in ship construction, ordnance and armor has done nothing more than make the ships larger, the guns heavier, and the armor thicker and more resisting. There is, however, a vast difference in efficiency between batteries of equal weight and the same general character but differently arranged. If one gun can be so placed as to do the work of two guns otherwise arranged, the gain which results is very great, for the weight saved can be used in increas-

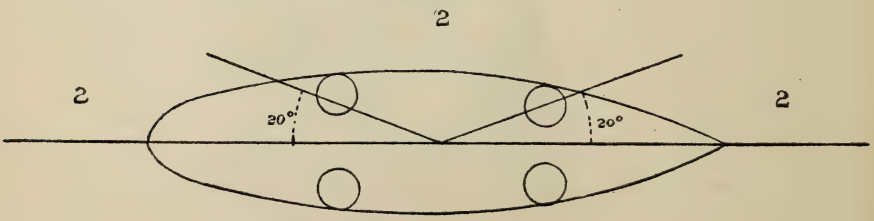
ing the protection of the remaining guns, while the decreased number of gun positions lessens the area of target, and consequently the chance of being hit. Now, a gun on the middle line of a ship is exactly equivalent to two guns, one on each side, provided it can fire across the deck. Again, a pair of guns in a single turret can be given the same armored protection on two-thirds the weight required if they are mounted singly. It follows almost of necessity that the heavy guns of an armored ship should be mounted in pairs in turrets on the middle line. Certain other arrangements having fictitious claims to superiority have been advocated and are embodied in many foreign ships as well as in some of our own. Let us examine these arrangements.

Assuming the main battery to consist of four turret guns of very large caliber, there are four feasible arrangements:

1. Four single-gun turrets, two on each side.
2. Four single-gun turrets, one on each side, one forward and one aft on middle line.
3. Two double-gun turrets, one on each side.
4. Two double-gun turrets, on the middle line.

The following diagrams show the relative weights of fire and arcs of train with these arrangements.

No. 1.



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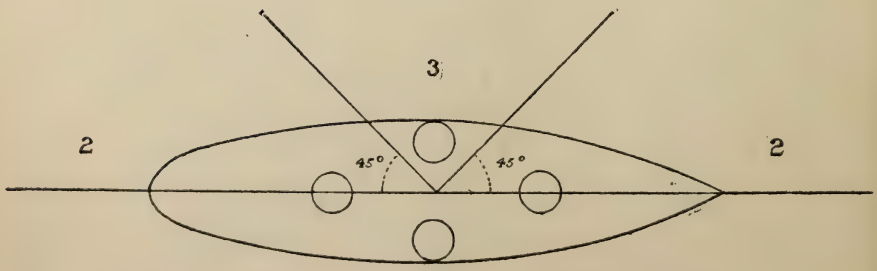

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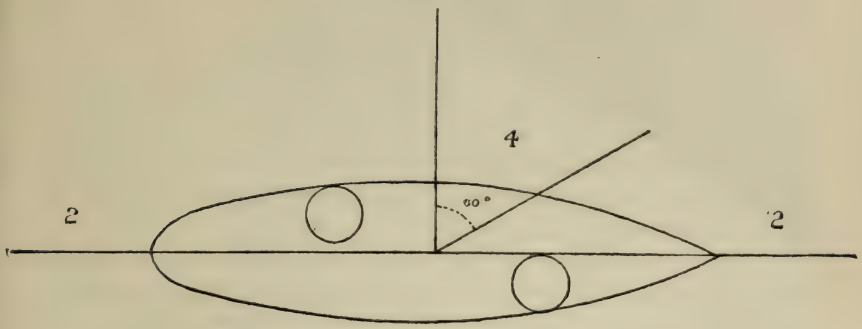

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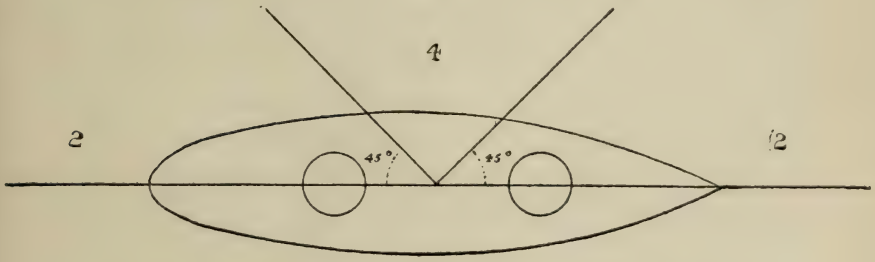
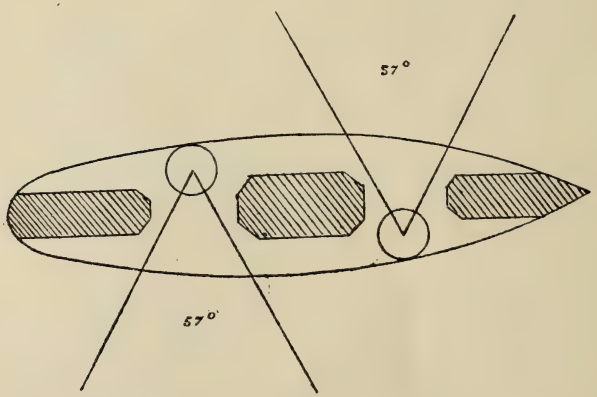


The first arrangement is partially exemplified only in some old French ships, the Richelieu and Ocean. The fact that but two guns can be brought to bear in any direction utterly condemns this arrangement, which is probably the worst possible one.

Plan No. 2 is a marked example of the sacrifice of real to fictitious advantages. The plausibility of the argument in favor of this arrangement is shown by the number of ships whose design embodies it—the Marceau, Hoche, Magenta, Pelayo and others. It is often claimed that with this design three guns bear on every point, but an examination of the diagram shows this not to be the case. It is doubtful if the side guns can fire directly ahead and astern, but granting that they do, even then but *two* guns bear over arcs of 45° on each bow and quarter, and only three on the remaining 180.° As compared with plan 4, this arrangement, with equal armor protection, costs 50 per cent. more in weight and gives only three-fourths the weight of fire on the

broadside and equal weight ahead and astern. Moreover, it gives almost double the target area of plan 3—four turrets with their barbettes and ammunition tubes as against two of but little greater diameter—as well as a grouping specially likely to be hit. Finally this arrangement renders it impracticable to carry an efficient secondary battery. If the side guns are to be fired ahead and astern no guns can be safely mounted in the space between the end turrets, and of course none can be placed outside of this space, except on a lower deck.

Plan 3 is exemplified in the Inflexible, Colossus, Agamemnon, Andrea Doria, Italia, Aquidaban, Maine, Ting-Yuen, and numerous other ships. It is another example of the sacrifice of real advantages to fictitious ones existing only on paper. This arrangement of a turret on each side has numerous variations,



the fore and aft distance between the turrets being more or less in different designs. Even in the largest ship it is impracticable to have the two turrets abreast each other, and in some ships they are widely separated, one being almost on the bow and the other on the opposite quarter. The Maine is a good example of the latter variation, and I will now try to show that in no case can this arrangement equal in efficiency that shown on plan 4, although the further apart the turrets are the better.

As will be seen, the Maine's guns have, on paper, 180° arc of fire on one side and 57° on the other. Even accepting this as practicable, the result is that only over an arc of 57° on each side can all four guns be used, whereas in plan 4 they all bear over 90° on each side. But in reality the forward guns of the Maine cannot

fire, safely, closer than 5° to ahead and 15° from astern, so that there is an actual dead angle of about 20° ahead and 20° astern. Moreover, the 57° angle shown on the plans must be greatly reduced unless we wish to destroy the superstructure on and in which the secondary battery guns are mounted. Manifestly, it should be the object in handling such a ship in action to bring all four main battery guns to bear on the enemy, but to do this the enemy must be kept within an arc of bearing of about 45° on one side or the other, whereas by simply moving the turrets inboard to the central line and concentrating the secondary battery between the turrets we at once increase to 90° on each side the arc within which all four guns bear on an opponent.

When the turrets are close together and on opposite sides of the ship, as in the Italia, the dead angles ahead and astern are increased. For example, in the Rugiero di Lauria the forward turret guns cannot fire nearer than 20° to the line of the keel forward and not so near aft, giving a dead angle of at least 45° ahead and 45° astern, while the arc of fire across the deck is no greater than in the design with turrets far apart. In fact, the further apart the turrets are the more nearly plan 3 approaches plan 4, and, consequently, the better it is.

The arrangement shown on plan 4 is the one adopted for our own battle-ships, the Indiana class, the Iowa, and the new battle-ships, and it is also embodied in the Camperdown, Trafalgar and other English battle-ships. This plan has the following overwhelming advantages:

1. It allows the greatest thickness of armor for a fixed weight.
2. It offers the poorest target to an enemy.
3. It gives the maximum weight of fire over the maximum practicable arc of train, and also over the arc of train most likely to be used.
4. It gives the best opportunity for mounting a large secondary battery.
5. It affords opportunity for safe stowage of a reasonable number of boats.
6. No interference of fire results from the use of any gun over its whole arc of train.

Concluding, then, that two turrets on the middle line afford the best disposition for the four heavy guns, the next question is what shall the remainder of the battery be? If it were practicable to carry another pair of the largest caliber guns in a third

turret on the middle line, it would be a most powerful arrangement, but several considerations prevent this. In the first place, the 900 or 1000 tons weight required is not available; in the second place, there would be great difficulties in the matter of supports and ammunition supply, on account of the necessary internal arrangements of the ship; and, finally, there would be no space left for secondary battery guns. But another consideration would lead us to condemn this arrangement; a very large part of all modern armored ships is protected by thin armor, four to six inches in thickness, which is invulnerable to rapid-fire guns but no match for the 8-inch caliber. If we carry only rapid-fire guns and 12-inch or 13-inch guns, we cannot get that *volume* of effective fire which is so desirable; the only projectiles which can penetrate the vital parts of the enemy will be delivered at no greater rate than one a minute, whereas by carrying 8-inch guns we can treble the number of effective shots. Concluding, then, that the four large caliber guns should be supplemented by some of medium caliber in addition to the rapid-fire guns, we have to determine their number and disposition. The Indiana class and the Iowa carry each eight 8-inch guns in four turrets arranged as in plan 1, but the arguments already advanced condemn this arrangement, and we have to choose between four turrets as in plan 2, or only two turrets as in plan 3.

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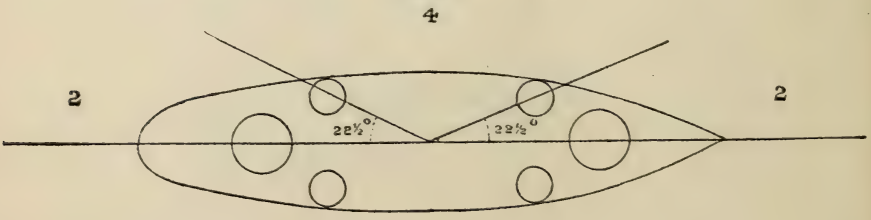

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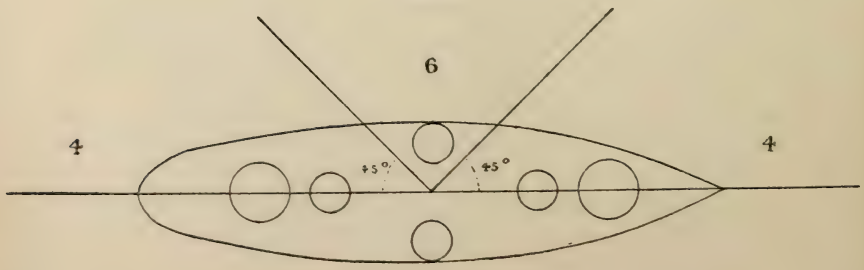

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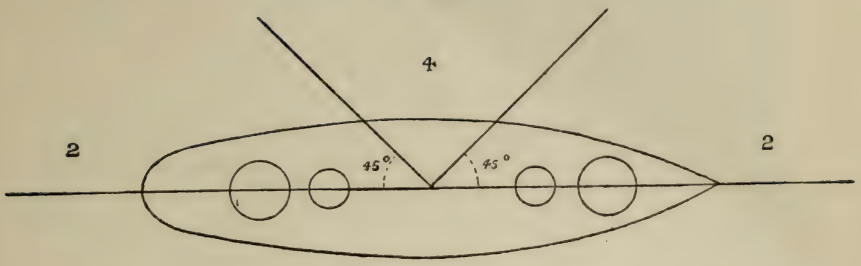


Comparing the three arrangements, it is at once apparent that at an expense in weight of four gun positions we get from the first plan the fire of four guns over 270° and of two guns over 90°; from the second plan on the same weight we get the fire of six guns over 180° and four over 180°, while from the third plan, one-half the weight, we get the fire of four guns over 180° and two over 180°. Where displacement is limited, as it is for our battle-ships, the greatly increased protection possible with the last plan is of itself enough to commend it, but other reasons are even stronger. With the four turret plans no space is left for a battery of small rapid-fire guns, at least four less 5-inch rapid-fire guns can be carried, and no space is available for stowage of boats. Moreover, the multiplication of gun positions increases the difficulty of regulating fire, a necessity with the battle-ship even more than with the cruiser. The gun captain, from his sighting hood on the turret top, can form no reliable estimate of distance, nor is he likely to be able to observe the fall of his shot. Some method of measuring the range and signaling the proper sight-bar setting to each gun position is essential, and the fewer the positions the easier to maintain communications.

One further and most important objection exists both to the second plan and to the third as it is shown, and that is the impossibility of the 8-inch guns firing safely over the 13-inch turrets. Blast plates have been proposed to cover the sighting hoods of the 13-inch turrets, but experiments at the Proving Grounds appear to have shown that they would prove ineffectual. Certainly with both 8-inch and 13-inch guns trained on the bow or quarter, it would fare ill with the people in the 13-inch sighting hoods when the 8-inch guns were fired.

It was to overcome this objection that the double-storied turret was first proposed by the Board of Ordnance, but it has many other important advantages.

Let us see what the advantages of the double-turret plan are, and what objections can be made to it.

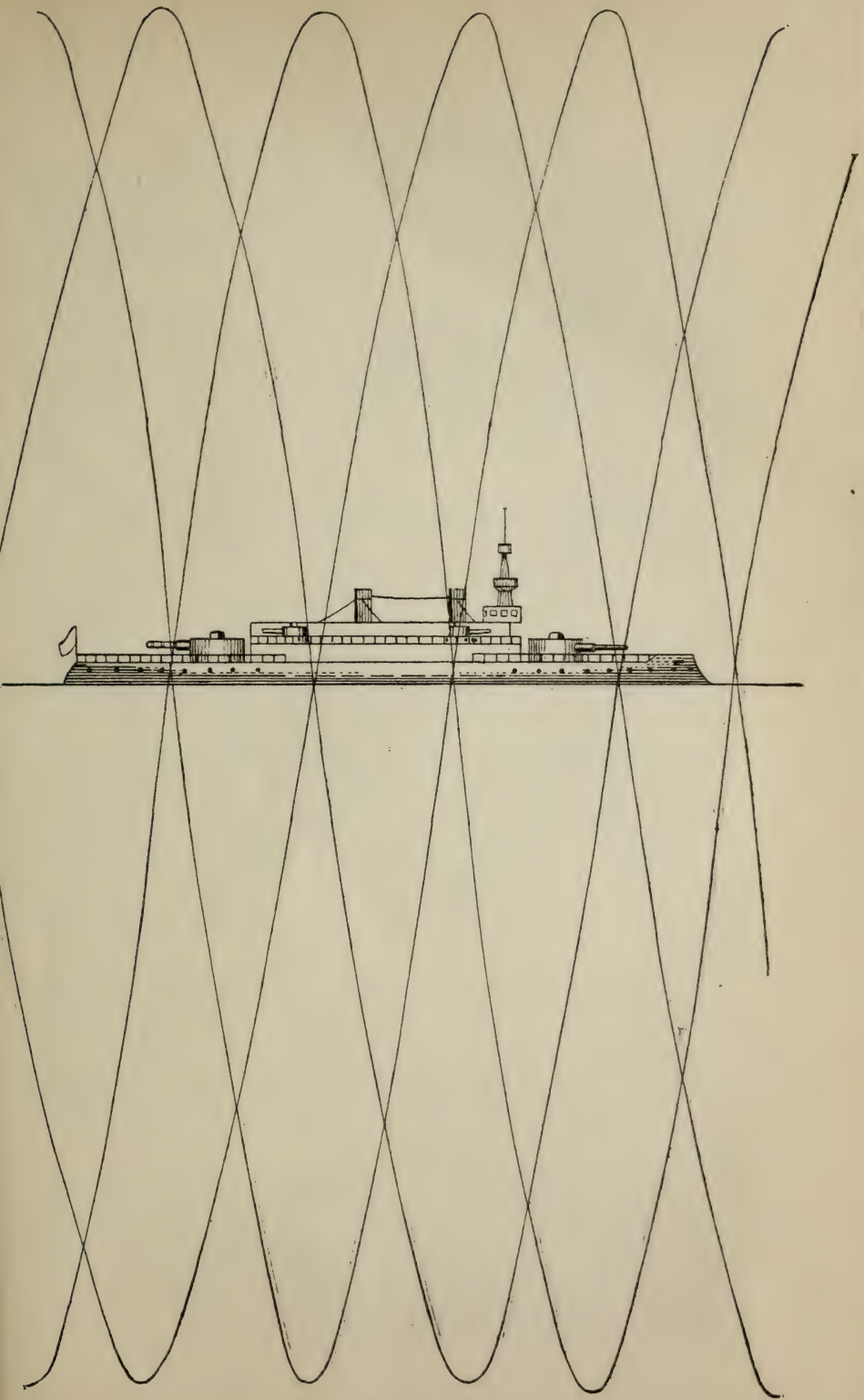
1. The saving of weight. Four 13-inch and four 8-inch guns can be carried on 246 tons less weight than four 12-inch and eight 8-inch, armor thickness being the same; or with equal batteries, four 13-inch and four 8-inch, and equal armor, 160 tons is saved. This weight, or even a small part of it, enables us to greatly increase the armor protection of the 8-inch guns.

2. Smaller target area and better disposition of target. No better target could well be offered than is afforded by the arrangement of two large and four small turrets. With the enemy a little forward or abaft the beam, a nearly continuous target is made by the turrets, and the thin ones are nicely arranged about the center of impact where the greatest number of hits will occur. With two gun positions widely separated, the maximum immunity from hits is attained.

3. Better control of fire. The double turret will be trained by one specially expert man, and better results must be given by this than where there are several turrets each with its own trainer. Moreover, there are but two main gun positions to which range and other directions must be signaled.

4. Vastly better opportunities for placing the secondary battery and for carrying boats. The clear space between the turrets gives room in the superstructure for at least fourteen 5-inch guns, and on the superstructure for as many small rapid-fire guns as desired, as well as for all necessary boats. Moreover, there is absolutely no interference of the fire of any gun by another.

5. Reduction in amount of machinery and mechanism. The training engines, roller paths, rollers, etc., of the 8-inch, the slightest injury to which would put the turret out of action, are done away with, and the training mechanism of the 8-inch guns being the same as for the 13-inch, is protected by 15 inches of armor instead of six or seven inches. Should the training gear of one of the main turrets be disabled with either design, the fighting force of the ship would be almost halved, unless by skillful manœuvring the guns of the disabled turret can be brought to bear; consequently, to do this would be the main effort of the



Scale $\frac{1}{100}$ in. = 1 foot.

The sinuous line indicates the intersection of the line of sight on the plane of the target-ship as the firing ship rolls through an angle of only four degrees, the speed of the target-ship being ten knots.

commanding officer, and with the double turrets both 13-inch and 8-inch guns would bear at the same time.

The objections urged to the double turret and their answers are as follows:

1. *Concentration of weights.*—This is not as great as in many foreign designs, nor even as great as in the Indiana class.

2. *Difficulty in supplying ammunition.*—This is not great. The 8-inch shell would be stowed in the 13-inch barbette, and, consequently, the men putting ammunition into the hoists would be on different decks and not interfere with each other. In the actual hoisting of the ammunition there is no trouble at all.

3. *Impossibility of training 8-inch and 13-inch guns on different parts of the enemy.*—This is an imaginary difficulty. An examination of the drawings will illustrate this. The intersection of the line of sight with the vertical plane containing the enemy's ship is a curve of rapid motion, and it needs but the recollection of actual experience in aiming guns at sea to convince any one of the absolute impracticability of selecting one portion of a ship as the target. "*Aim at the middle of the target*" should be the almost invariable rule. In that way the maximum number of hits will be obtained. The old experience that "the waist of the ship is a death-trap" illustrates this fact, the greatest number of hits naturally being about the point aimed at; but the theory of probabilities of fire indicates that with the errors common to gun fire at sea, even where the objects to be struck are at the ends of the ship, you will get the most *hits* by aiming at the middle between them.

If concentration of fire is desired, then the double turret renders it possible, all four guns being fired simultaneously by electricity, but in no other way can it be obtained.

But it would be too long to fully discuss this arrangement, and I can only say that the more I have thought of it and discussed it the more firmly I have been convinced of its advantages.

As to the question of the remaining battery of battle-ships, there seems to be no doubt but that it should be made up of rapid-fire guns, and these can only be placed in the superstructure between the main turrets. In the Kearsarge and Kentucky there are to be fourteen 5-inch rapid-fire guns in broadside, and these guns cannot fail to add greatly to the fighting force of the

ships. A very large area of every ship must be unarmored, and while there may be no vital parts so unprotected as to be vulnerable to the 5-inch gun, still the wreckage of the unarmored portions must tend to the demoralization of the crew. Moreover, smokestacks, ventilators, masts and boats are targets whose destruction may be a serious injury, while the gun ports and sighting holes offer possible chances of entry into the armored structures, and the water-line at the ends, as well as the sides above the belt amidships in many ships, can be so cut away as to endanger stability notwithstanding coal and cellulose protection.

As against the virtues of such a battery let us consider those of the new battle-ships which follow the Kearsarge and Kentucky. These ships are to have four 13-inch guns in turrets on the middle line, but in place of the 8-inch and 5-inch they are to have fourteen 6-inch rapid-fire guns, ten mounted in broadside between the 13-inch turrets and four on top of the superstructure also in broadside, and so arranged that one on each side fires right ahead and one right astern. Taking the rates of fire as one round a minute for the 8-inch, two and one-half rounds a minute for the 6-inch, and three rounds a minute for the 5-inch, it will be seen that with the Kearsarge plan the weight of fire per minute is 2050 pounds on the broadside and 500 ahead or astern, while with the later plan it is only 1750 on the broadside and 500 ahead and astern. But the main objection to the second plan is that the volume of effective fire is enormously diminished by the omission of 8-inch guns. The large area covered with thin armor is fairly safe from the 6-inch guns at fighting ranges, whereas the 8-inch projectile at any range, and at even a considerable angle of incidence, will penetrate it. If we measure the value of the two batteries by the rules heretofore laid down, it is evident that the Kearsarge's battery will prove much the more efficient.

We have finally to consider what is the best battery for the armored cruiser class, and first, what is the function of the armored cruiser. I consider her to be simply a ship big enough to be partially armored, but not big enough to carry very heavy guns or very thick armor, and as with all other classes of war-ship, she should be designed with a view to have at least equal chances in battle with any other ship of equal size. She is a

cruiser of sufficient displacement to be armored, and consequently requiring guns capable of piercing armor. From my point of view, every ship of more than about 4500, and of less than about 9000 tons displacement, should be an armored cruiser. It is folly to build 9000-ton ships which can be knocked out by properly armed ships of half their size.

We have thus far designed but two armored cruisers, the New York and Brooklyn, the first of about 9000 tons, and the last of about 10,000 tons displacement with full bunkers. The batteries of these ships are respectively six 8-inch and twelve 4-inch guns and eight 8-inch and twelve 5-inch guns.

The New York's 8-inch guns are arranged four in two turrets on the middle line and a single gun in each waist. By simply putting the two waist guns in a turret on the middle line, which could be done without changing the arrangement of boilers or machinery, how much more powerful her battery would be! In order to use the 4-inch guns the enemy must be kept not greatly forward or abaft the beam, and in this position, with present design, five 8-inch guns would bear, while by the proposed change all six would bear. In the same way how greatly improved the Brooklyn would be by putting her side 8-inch turrets on the middle line, or if that be impracticable, which I do not believe, by giving her only three turrets, all on the middle line. These would give exactly the same fire on the beam as is now given by four turrets, and the saving of weight could be used to great advantage in increasing the thickness of the turret armor.

As for the rapid-fire guns of an armored cruiser, they should be arranged on a single deck in broadside, and should be as many in number as space will allow.

There is no lack of displacement available if we only dispense with the many worse than useless weights which we now carry. Let all useless bulkheads be removed, all wood sheathing torn off, and we can put a battery of rapid-fire guns on the New York and Brooklyn that will render it unnecessary to answer the frequent and annoying question of visitors to those ships, "But where are your guns?"

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE YACHT "DEFENDER" AND THE USE OF ALUMINUM IN MARINE CONSTRUCTION.

By Richmond Pearson Hobson, Asst. Naval Constructor, U. S. Navy.

No craft in the annals of yachting centers about itself such features of general interest as the yacht Defender. Perhaps the greatest series of races in these annals is the one that represents in its sphere the great fact of modern times—the greatest fact, it may prove to be, of all time—the rise of the New World, a rise to greatness that has reached, and in some respects has passed the point of successful rivalry with the Old World.

Among the yachts connected with the series of races for the America's cup, Defender is in many respects unique, standing head and shoulders above all the distinguished number.

The last races came at a time of high tide in yachting interest both abroad and in the United States, when rivalry was keenest and the evolution of the racing craft seemed to have reached its maximum. The determination to win back the lost trophy was made years in advance, and one can trace the course of deliberate, scientific, tireless effort to this end, till at last it seemed, with great reason, that invincibility had been reached in Valkyrie III.

It was immediately recognized in America that the defense of the cup could not be left to any yacht yet built; moreover, the time after challenge would be too short to permit experiment. Valkyrie III was the successor to a dynasty that reached its climax of perfection before the challenge was sent; while the American champion might be expected to follow the line of its predecessors,

and might be expected to be the climax of a sequence of representatives, yet there was but one chance of producing the climax.

The sense of danger aroused the American yachtsmen to the necessity of co-operation. Effort combined and centered upon producing a single craft. The order was placed with Herreshoff Bros., of Bristol, R. I., and cost and all other considerations were subordinated to the one object, speed. The yacht built must win.

It was natural, under these conditions, to expect boldness, for the builders, though sure in execution, have been characterized by boldness in design.

The shape this boldness took for realizing a maximum of power was along the line of weight distribution, for lowness of center of gravity, rather than along the line of maximum metacentric radii, or power of form. The advantage of excessive lowering of the center of gravity, instead of the raising of metacenter, becomes apparent, without further explanation, from reference to the fact that power of weight, determining the position of the center of gravity, does not incur, as does power of form, determining the position of the metacenter, the increase of head resistance and frictional resistance that sets in when the vessel heels or is in a seaway.

The method adopted for lowering the center of gravity consisted not only in placing a maximum weight of lead on the deep fin keel, as found also in the Challenger and other yachts, but also in reducing to a minimum the upper weights, the saved weight appearing in the form of additional lead on the keel, being equivalent in effect to a transference of weight downward through a great desistance.

The reduction or economy of weight, particularly of high weights, which thus constituted the characteristic feature of the yacht, places her construction alongside of marine construction in general, and of naval construction in particular, where weight of hull and fittings affects intimately the limit of the military qualities themselves.

This coincidence of purpose alone would make the yacht an interesting study for the naval architect, but the form the purpose took enhances the interest, makes it general and intense, for it adopted a new material—aluminum—which, from its extreme lightness, has been offering great hopes to the naval architect, but which, from its corrosion in salt air and salt water, has

checked, if it has not effectually shattered these hopes. Moreover, the conditions were peculiarly such as to constitute a severe test of the virtues and failings of the new metal.

In view of this similarity of purpose with naval construction, particularly the bearing on torpedo-boat construction, and of the value of the experiment with aluminum, the Navy Department directed an inspection of the yacht and a report on her "method of construction." This report is given in Part I practically as it was made after inspection at Bristol just before the yacht left the builder's hands.

In August last, more than a year afterward, a second inspection was made at New Rochelle, through the courtesy of Oliver C. Iselin, Esq., to determine the conditions of preservation and the conduct of the new material in the face of the deteriorating conditions of service. Since it is on the question of corrosion that the use of aluminum for marine purposes hinges, an effort was made to throw, if possible, some additional light upon the subject, particularly at the present time, when, notwithstanding the advantage it offers, aluminum has been unfavorably passed upon, both abroad and in this country, upon grounds that appear to be incomplete. Samples of corrosion taken from the Defender, also a sample of a corroded aluminum plate, together with a sample of the salt water in which, in a closed vessel, the corrosion took place, the latter furnished by Professor A. H. Sabin, were sent to the chemist at the Navy Yard, New York, with directions for a qualitative and a quantitative analysis, with a view to determining the phenomena of corrosion in the particular case, the attacking agents, the soluble and insoluble products.

The value of an intimate knowledge of the phenomena is evident, serving as it would as a basis for research and experiment to find preventative preparations.

A sequence of heavy pressure in the chemical laboratory has prevented as yet the analyses, and effort to hasten them since the writer's detachment from the New York Navy Yard has been of no avail. Only an incomplete, preliminary analysis of the corrosion from Defender has been reported, an analysis so incomplete as to be of no material value.

It has therefore been decided to give in Part II the result of the study of the subject of the adaptability of aluminum for marine construction, without the original data hoped for on the question of corrosion.

Part I.—The Method of Construction of the Yacht Defender.

1. *Preliminary Description.*

The boat was examined while afloat at anchor. Her general form is indicated in Figs. 1 and 3. Her approximate hull dimensions are as follows: Length over all, 122 feet 3 inches; length on load water line, 90 feet; maximum beam, 23 feet; beam at load water line, 22 feet; draught, extreme, 19 feet.

The idea that gives the distinguishing feature to this advance type, as will be seen below, is the realization of extreme sail

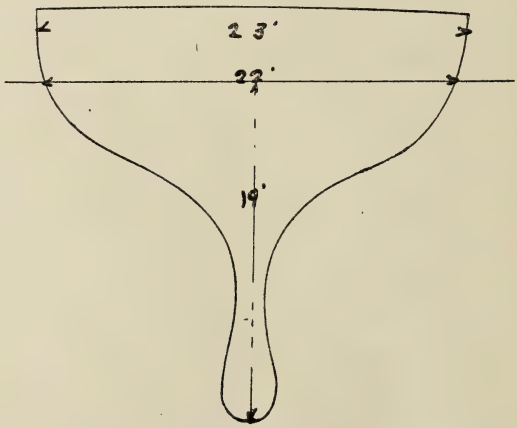

Fig. 1.—Midship Section in Outline—approximate only.

carrying power from a great metacentric height, initial and under inclination, realized from the disposition of weights. Though realizing a high position of the metacenter from an elevated position of the center of buoyancy and long metacentric radius, the extreme is reached in the low position of the center of gravity.

The great metacentric height and consequent sail-carrying power is derived more from the element of weight than from the elements of form.

The method adopted in realizing the low position of the center of gravity is that of reduction in weight of hull and fittings and the addition of weight to the keel, weight being taken from the upper portions and added to the lowest point.

FIG. 2.—Longitudinal Profile in Outline.

The method of realizing a reduction of high weights is the use of light materials, of light scantlings, with a light method of construction and fastenings.

The reduction of frictional resistance and of liability to deterioration are sought in the use of bronze, manganese bronze, for water-washed portions.

The features of the distinguishing methods thus identify the construction, in the objects sought, with the construction of vessels of war, particularly torpedo vessels and torpedo-boats.

2. *The Method of Construction.*

Referring to the sketch of the midship section, Fig. 3, the construction is as follows:

1. The Skeleton.—A steel angle, 4″ x 4″, closed to the angles of the water lines, from ¼″ to ⅜″ thick, forms the stem and binds the ends of the shell plating, with double riveting, rivets of bronze for the bronze plating, diameter ⅝″, and of aluminum for the aluminum plating, diameter ½″.

A bronze casting, 4″ deep by 20″ wide, of the form indicated in sketch, forms the *keel.* On its under side is attached the lead, shaped to the form indicated, secured by bronze tap bolts 8″ long by 1¼″ diameter. The bronze *shell plating* extends to cover the lead, reducing the frictional resistance, and giving additional support, securing to the lead by bronze taps 5″ long by ¾″ diameter.

The *frames* are steel angle bulbs made in two parts between the keel and top sides, strapped and riveted as indicated, spaced 20″ throughout, an angle being substituted for the bulb at the forward extremity, frame No. 1. They stop at the keel, which is spanned by floor plates of ¼″ bronze plating, 12″ high, secured to the frame on each side by five rivets of ⅝″ diameter. Alternate frames have in addition deepened *floor plates,* of $\frac{7}{32}$″ steel, extending, as shown, to the angles uniting the frames at about one-third their height from the keel. These angles are steel, 2″ x 2″ amidship, and 1¾″ x 1¾″ forward and aft. The frame angle bulbs are 3½″ x 2″ amidship. The following is their scantlings throughout, beginning forward: Frame No. 1 is an angle, as stated above; from frame No. 2 to frame No. 9 the angle bulbs are 2½″ x 1½″; No. 10 is 2¾″ x 1¾″; from No. 11 to No. 24 they are 3″ x 1¾″; from No. 25 to No. 44 they are 3½″ x 2″; from No. 45 to No. 58 they are 3″ x 1¾″; from No. 58 to stern they are

2½" x 1½". The dimensions for the bulb of the frame angle bulbs, 3½" x 2", are ⅞" x $\frac{9}{16}$".

About four and a half feet above the steel angles that bind the

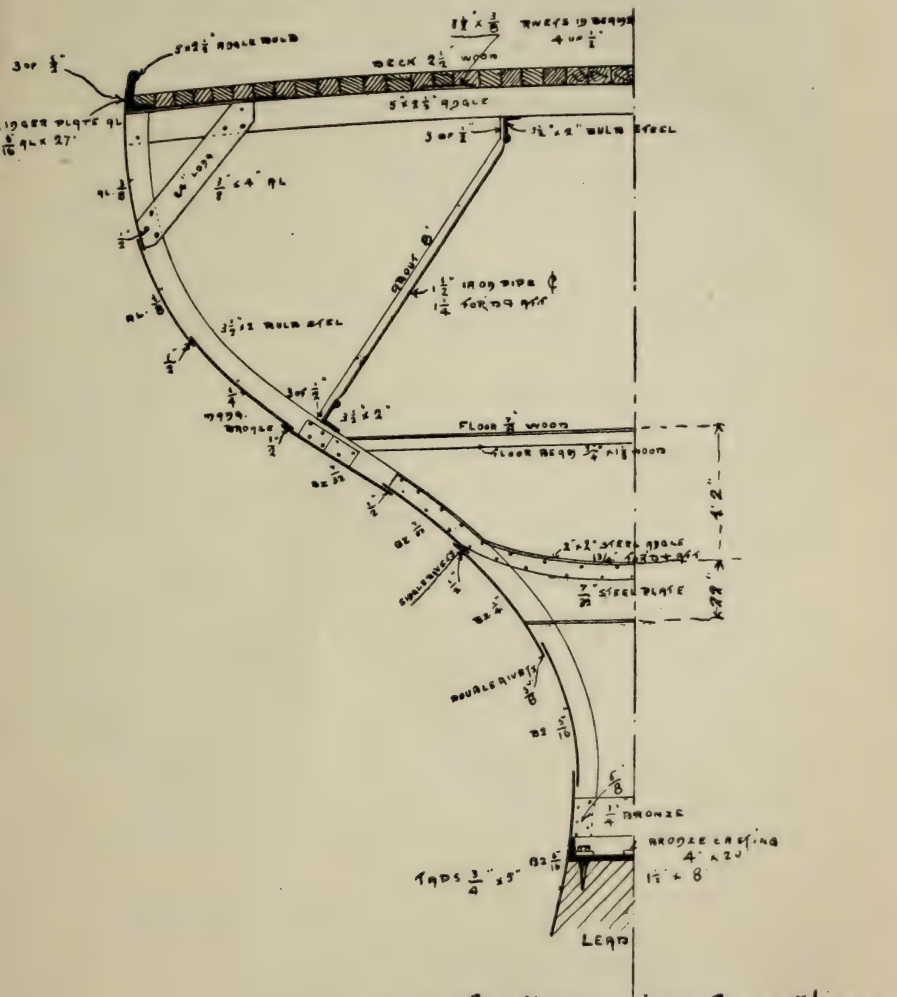

FIG. 3.

two sides of the frames are *wooden beams*, 3¼" x 1⅛", secured to the frames, adding stiffness and forming support for the platform or lower deck.

The *beams* of the upper or main deck are aluminum angle bulbs, 5″ x 2″, spaced 40″, fitted to only alternate frames, the frames without beams ending without fittings under the deck stringers. The beam arms are secured to the frames against which they sit back to back by three rivets of ½″ diameter and by a single strip of aluminum plating 24″ long, 4″ wide and ⅜″ thick, forming a triangle with the frames and beam arm, secured by three rivets at each end of ½″. The two beams between which the mast is strapped are of steel, 4¼″ x 2¼″.

A *bilge stringer*, steel angle bulb, 3½″ x 2″, extends throughout the entire length on each side, at the height indicated in the sketch. A corresponding inverted steel angle bulb, 3½″ x 2″, extends under the main deck beams in the position indicated in sketch along the whole length on each side about 4′ from the central line.

The bilge stringer angle bulb and the inverted angle bulb under beams on each side are connected by 14 *struts* made of iron piping, 1½″ amidships and 1¼″ forward and aft, spaced five frame spaces. These pipes have forgings welded in their ends and flattened to lie on the backs of the angle bulbs, to which they are secured by three rivets of ½″ diameter.

A *deck stringer plate* of aluminum, varying from 28″ to 24″ in width and $\frac{5}{16}$″ thick, extends over the beams from end to end. On this stringer plate, along its outer edge, extends an aluminum angle bulb, 5″ x 2½″, which receives the upper edge of the shell plating and forms the upper ending of the hull at the sides. The deck beams are strapped in addition by diagonal plates of aluminum, ⅜″ thick, varying in width from 5″ aft to 7½″ forward, the four converging on the mast being 10″ wide. The length of these strapping plates and their disposition are indicated in sketch, Fig. 4.

Thus the skeleton consists of a steel angle stem, a bronze keel, with lead underneath, steel angle bulb frames, with floor plates of alternating heights, of bronze at the bottom and steel above the bronze, with steel angles binding the frames on the two sides, wooden deck beams for the lower deck, and aluminum angle bulbs for the main deck beams, fitted only to alternate frames, steel angle bulb bilge stringers, one on each side, inverted steel angle bulbs on under side of main deck beams, one on each side, two rows of inclined struts between bilge stringers and inverted

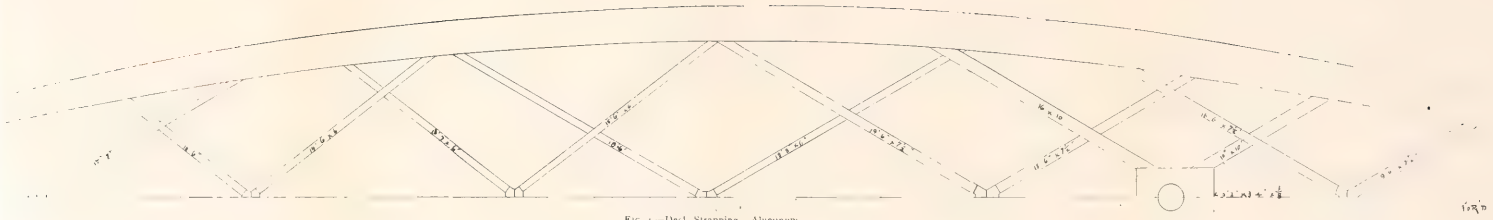

FIG. 4.—Deck Strapping Aluminum.

angle bulbs under main deck beams, one row on each side, spaced every five frame spaces, aluminum deck stringers and angle bulb at sides of main deck, and diagonal deck strapping fore and aft.

2. THE COVERINGS.—The *shell plating* is on the raised and sunken system, with liners behind frames under outside plating, secured to frames by a single row of rivets of ½" diameter. All butt straps are double riveted.

Strake No. 1, covering the lead and overlapping the keel and lower part of frames, as indicated in sketch, Fig. 3, is an outer strake of manganese bronze $\frac{5}{16}$" thick amidship, secured to the lead by bronze taps ¾" diameter and 5" long. The lap with strake No. 2 is secured by two rows of rivets of bronze ⅝" diameter.

Strake No. 2 is an inner strake of $\frac{5}{16}$" manganese bronze. The lap with strake No. 3 is double riveted, ⅝" bronze rivets.

Strake No. 3 is an outer strake of ¼" manganese bronze. The lap with strake No. 4 is single riveted, ½" bronze rivets.

Strake No. 4 is an inner strake of $\frac{7}{32}$" manganese bronze. The lap with strake No. 5 is single riveted, ½" bronze rivets.

Strake No. 5 is an outer strake of $\frac{7}{32}$" manganese bronze. The lap with strake No. 6 is single riveted, ½" bronze rivets.

Strake No. 6 is an inner strake of ¼" manganese bronze. The lap with strake No. 7 is single riveted, ½" bronze rivets. The load water line falls on this strake near its upper edge, between the water line and the aluminum plate above.

Strake No. 7 is an outer strake of ⅜" aluminum. The lap with strake No. 8 is single riveted, ½" aluminum rivets.

Strake No. 8 is an inner strake of ⅜" aluminum. This strake is the highest. The upper edge secures to the back of the angle bulb, forming the top line. The lower ends of the strips securing beam arms fall on the lower part of this strake.

The *decks* are of wood, 2¼" thick for the main deck and ⅞" thick for the lower deck. Liners are fitted over the beams of the main deck between the strapping plates. The deck planks are secured to each other by horizontal nails in addition to being secured to the beams. Around the mast a steel tie plate, 5′ 3" x

3′ 4″ x ⅜″, secures the ends of the strapping plates and the four beams in the vicinity.

Thus the coverings consist of manganese bronze for the water-washed portions of shell plating, and aluminum for the top sides, with wood for the decks, and steel for special plates.

3. Fittings.—The *socket for stepping* mast is made of steel angle bulb, 5″ x 2½″, bent to the form of a circle with the ends welded and strapped. The flange, which is on the exterior, sits on a foundation plate of steel. The stepping is stiffened by a partial vertical keel or keelson and by special floor plates on the frames adjacent, with angles 4″ x 4″ on one side and 2″ x 2″ on the other, with vertical angles 2″ x 2″.

The pin rails are of steel piping. The rigging on each side is secured to steel eye bolts attached to 5 chain plates, about 4½″ wide and ⅝″ thick, extending down to the lower deck, riveted to the shell plating.

The jibboom is guided by two main straps of bronze about a foot long with flanges at the ends, and by an additional narrow strap of simple bronze plating.

The fid is of aluminum, in the form of a yoke which receives tie rods which are of one piece bent around the stem and, passing through the ends of the yoke, are set up by nuts, which permit of an adjustable strain on the single jumper or martingale of steel wire, secured to the stem a short distance above the water line. There is no lateral support of the jibboom.

The standing rigging and topping lifts are of light steel wire. Blocks are of Oregon pine or spruce with straps and sheaves of aluminum. Cleats are of hard cast bronze. Eye bolts are of steel. The spars are of Oregon pine and spruce. The internal fittings are of light wood with minimum thickness. Partitions and partial bulkheads are of canvas, held by a light wood framing. The water-closet fittings are of aluminum, with small pump of aluminum. The bunks for the crew are of ½″ gas tube frames, 6′ x 23″, covered with canvas, hinged lengthwise to the side and folding or dropping down. They are three tiers deep, with about 20″ vertically between the bunks. They are secured in the horizontal position by straps from the reverse angle bulbs under the main deck beams.

Thus the fittings are of steel, bronze, aluminum or wood, according to the requirements.

3. CONCLUSIONS.—The method of construction as above described presents three prominent features, namely:—

1. Simplicity and directness of construction.
2. The use of new materials and their combination with steel.
3. Lightness of scantlings.

The complex nature of the forces to be resisted, the combination of pronounced twisting and a heavy thrust of mast with the usual forces, would lead to the expectation of complexity, whereas examination shows an entire absence of redundant parts, and even of parts found in usual construction.

The examination of the parts in view of the forces to be resisted shows a singular directness of purpose for each part or piece that enters the construction. These characteristics, simplicity and directness, are so evident from the sketch of the midship section that they need not be pointed out in detail. Notice should be taken, however, of the use of angle bulbs instead of simple angles or combinations of angles. The sectional moment of inertia being greater for the angle bulb, there is a gain in stiffness, or a saving in weight for the same stiffness. Notice should be taken also of the simplicity of fastenings, the economy of rivets.

Special attention should be given to the system of struts, which, though exceedingly light, give to the transverse sections a girder-like nature hitherto unattempted afloat. Special attention should be called also to the disposition for insuring continuity of resistance in the main deck, to the longitudinal angle bulbs under the deck beams, and the combination of angle bulbs and wide deck stringers at the sides, but especially to the diagonal strapping which opposes itself directly to the twisting forces referred to above, note being taken also of the fastenings of deck planks to each other.

It may be added that the characteristics in question appear in full relief when the boat is conceived inclined under the great localized forces; when the parts are conceived distributing these forces and transmitting them to the resisting forces without, the structure will be seen to present remarkable stiffness of form, remarkable resistance to deformation, combined with the simplicity of structure described above.

In sum, the boat is an architectural departure and is an interesting study for all architects. For the marine architect the

study is of practical value, for the departure is along the line of his constant effort to realize a maximum of resistance to complex forces with the minimum of weight.

The realization of this main object, however, is not confined alone to the *disposition* of the material, but extends also, with even more marked characteristics, to the *selection*. The lightest strong metal known to architecture is used wherever characteristics other than weight do not prevent. The shell plating of the top sides, the main deck beams and strips securing them to the frames, the deck stringers and top side angle bulb, the deck strapping plates, and various fittings, enumerated above, are of aluminum. The builders claim a gain or saving of ten tons over steel construction as used in the yacht Colonia of nearly similar build. The transfer of this weight from the top sides to the keel, through a vertical height of about 21′, causes the distinguishing characteristic referred to at the beginning, that of a lowness of center of gravity which places this boat apart from all other products of marine construction.

This use of aluminum presents particular interest from the effort it represents to realize not only a gain in weight, as yet moderate in quantity when compared for simple strength with steel, but also the more pronounced advantage afforded by a more efficient disposition of metal, a section of greater inertia, and consequent greater stiffness, than can be realized with the smaller quantity of the heavier and stronger metal.

In addition, in view of service and deterioration which sets in from the surface and which may be looked upon as penetrating readily a certain distance and then ceasing, the thicker plate of the lighter metal offers decided advantage over the thinner plate of the stronger metal, assuming equality of strength when first built. These features are important ones in maritime construction, particularly in naval construction.

The last feature is of particular importance in torpedo-boat construction, which requires the use of plates of extreme thinness.

The advantage of taking weight from lower portions and putting it on the keel is less pronounced than for the case of the upper portions. Further, a special bronze alloy, stronger than steel, though heavier than aluminum, offers, when polished, pronounced advantage over all painted or varnished surfaces, according to the experience of the builders, in smoothness of surface.

The water-washed portions of the shell plating are of manganese bronze, from which results of ultimate strength are realized about 12 per cent. in excess of the results of steel used for the same purpose. In view of the additional fact that the under water parts are for the most part on the compression side of the hogging girder, and will consequently be less called upon for resistance within tensile elasticity, and of the fact that bronze offers advantages in maintenance of smoothness, according to the builders, and decided advantages in resistance to deterioration, this feature is one of particular interest in naval construction, particularly in the case of torpedo-boat construction, where deterioration is most injurious.

In sum, the construction of the boat seeks to realize the advantages offered by two materials that may be considered new, and presents for study all the interest that attaches to the experiment of these materials in the new field of hull construction.

But in seeking to realize the advantages of the new materials the builders have not lost sight of the advantages still offered by the old. For the frames and floor plates and for special fittings like the tie plates around the mast and the chain plates and, in general, the parts where the advantages offered by aluminum and bronze are less in evidence, and where special strength without special stiffness is desired, use is made of steel, with evident advantage. It should be noted that the lower parts of the floor plates, 12″ in height, which are liable to corroding effects of bilge water, are made of bronze.

In sum, the boat seeks to realize the advantages offered by all three of the materials, aluminum, special bronze, and steel.

Though aluminum boats have been built abroad, and though bronze has been previously used by the builders in conjunction with steel on the Vigilant, the combination of aluminum, bronze and steel has never been attempted. In material, as in architecture, the boat stands apart. But, further, simplicity and directness of construction and new materials and new combinations of materials are not the only characteristics of this remarkable boat.

An examination of the scantlings as described above, and as seen on the sketch of midship section, shows throughout a lightness that is remarkable when it is remembered that the boat is essentially a structural experiment on untrodden ground. This lightness of scantlings is most marked in the region of the mast.

It is true that here are found the maximum dimensions of pieces, the heaviest scantlings of outside plating, that the two beams between which the mast passes are of steel instead of aluminum, that the deck strapping plates are increased in width, and that a special steel tie plates binds up the four beams, and the ends of the four strapping plates, but even with these special dispositions the provisions do not appear commensurate with the local strains, particularly on the weather side, that the structure will undergo by reason of the narrow spread of the stays, introducing an enormous thrust of the mast and crushing force between the sides due to the enormous spread of sail and the great height of the center of pressure. Notwithstanding the special provisions enumerated, it appears not improbable that a heavy wind, particularly if applied suddenly, will cause the structures in the region of the mast to spring, if not to give way, it being assumed that the mast is sufficiently robust not to give way beforehand. In view of the experimental nature of the boat, this feature of lightness, particularly in the region of the mast, is second in its striking nature only to the features described above, and offers an interesting field for the calculation of the strains to which the materials are liable to be subjected. This feature has not been included in the present examination of the "method of construction," but a summary investigation leads to the conclusion that the scantlings are such as to bid fair to afford a conclusive, if not crucial, test of the strength of the new materials.

But the test of strength is not the only test in store for the new materials: the test of endurance will also be conclusive. The materials are in a combination that will produce serious effects of galvanic action, if such action is liable to take place under the conditions of service. The aluminum and bronze are not only in contact with each other, but are both in contact with steel, and this contact is most intimate in the case of rivets passing through two or more different materials, as is the case of rivets between frames and shell plating. It is to be noted that methods have been used to obviate as far as possible the liability to this action, such, for instance, as the avoidance of the use of aluminum below the water, the use of bronze for the bottom of the floor plates where liable to be in contact with bilge water. The conditions of service will test the efficiency of these methods.

The test will extend to the use of bronze for the water-washed

surfaces, to the extent of the advantage it offers for the resistance to deterioration and to fouling, and, if possible, it should be made to extend to finding the extent of the advantages it offers in frictional resistance, the increased smoothness compared with painted and varnished surfaces.

Thus, in sum, the Defender, while presenting a remarkable study of simplicity of construction and efficiency of distribution of materials, embodies two new materials in such light scantlings as to offer a test of their strength, and in such combination and disposition as to offer a severe test of their qualities of endurance, of resistance to deteriorating influences.

The objects throughout, that of realizing a maximum of strength with a minimum of weight, particularly in the upper parts, of realizing a minimum of skin resistance, are identical with the objects in naval design, more particularly in torpedo-boat design; while the methods adopted, the use of three materials, two of which are new, in a combination which seeks to realize the special advantages of each, and the means resorted to to prevent the bad effects liable to the combination, are all steps across the border at which torpedo-boat construction has arrived into the fields beyond.

This interesting production has sought to realize the extreme of sailing advantages along the road that torpedo-boat construction must follow in coming developments of hull construction, and the conditions are peculiarly favorable for its cutting away many of the obstacles and indicating what changes in direction are best for entering the new ground.

To realize the advantages of the experiment, investigation should extend to cover the behavior of the new materials under the tests of strength, during stress and after repeated stresses, and under the tests of endurance and resistance to deterioration.

Part II.—The Use of Aluminum in Marine Construction.

A new material enters the realm of structural usage by creating new fields or else by outstripping the occupants of old fields.

Broadly speaking, the field of marine construction is now occupied by steel, wood, and the alloys of copper. Aluminum must, in consequence, wrest from these older materials the foothold and territory it is to occupy.

A part of this field, associated principally with the motive power, is shut off from aluminum by an impassable barrier of temperature. A fraction of the temperature at which bronze and steel remain unmodified will overthrow the physical properties of aluminum. Roughly speaking, aluminum is barred from temperatures where human life cannot exist. Not far beyond the boiling point of water it loses half its virtues of resistance, and above 400° F. should not be subjected to strain.

In addition, by reason of its softness, aluminum is debarred use as armor, which constitutes an important section of naval construction. Moreover, as will be seen below, its inability to extinguish sudden and violent dynamic forces excludes usage for armor supports and fastenings.

Of the remaining fields not thus cut off, principally hull construction and hull fittings, the vast bulk is occupied uncontestedly by steel. Wood and bronze (the term bronze being used broadly to signify the alloys of copper) have only special provinces, wood finding its principal use where stiffness, not strength, is required, and where the service does not require a hardness of surface, but facility of working; and bronze finding its principal use where complexity of form requires special properties for casting, or where special corroding agents are to be resisted, or where a wearing surface is desired to save the usure of steel.

Even the special properties of bronze and wood may be considered as possessed, to a greater or less degree, by steel. Aluminum then will be made to measure properties with steel, the special properties of wood and bronze being considered only incidentally where they appear in the comparison with steel.

The factors whose product or resultant determines or measures the adaptability of a material for structural purposes are strength, weight and cost, strength and cost being used in their broad sense. The measure of adaptability for strength is the approximation to a maximum, and for cost and weight it is the approximation to a minimum. In marine construction the problem of design in general is to realize within a fairly wide range of cost a given or required strength with a minimum of weight.

The underlying object in general is to realize a maximum military efficiency for each unit of weight.

In the industries, however, and in general for land structures, the purpose of design is to realize a given or required strength

with a minimum of cost, a minimum of weight in general accompanying a minimum of cost. The underlying object in general is to realize, within a wide range of weight, a maximum return for each unit of cost or capital invested.

For the present purpose, therefore, the comparison of aluminum and steel will be for strength and weight first, then for cost.

The question of endurance, or length of life, which will be seen to be of capital importance, is essentially one of cost, though intimately associated with strength, since the rate or rapidity of dissipation of strength determines the length of life.

The figures used in the comparisons of aluminum are the latest ones of the Pittsburg Reduction Company, for their best 5 to 10 per cent. alloys. These figures are probably a little high for the general status of aluminum at the present moment, particularly when the comparisons of simple strength are made with mild steel, mild steel being used throughout, as it is the most regular, and best illustrates, as will be seen, the great contrast of the two metals in their resistance to dynamic forces; but they have been retained in view of the present rapid state of progress in the production and manufacture of aluminum, a state corresponding to the stage of steel about ten years ago, when still on a steep rise far away from the proximity of the maximum in the curve of progress.

A.—Comparison for Simple Resistance.

1. *In tension.*

(*a*) *Ultimate tensile* strength:—Steel, 60,000 lbs. per sq. in. Aluminum, 40,000 lbs. per sq. in. Ratio, 1 to 1.5 or 2 to 3.

Cross sections for *equal ultimate* tensile strength, see Figs. 5 and 7.

Weights:—Weight of one cubic inch of steel, 0.283 lb.; of aluminum, 0.094 lb. Ratio, 1 to 3.

Weights for *equal ultimate* tensile strength, aluminum 1, steel 2.

(*b*) *Elastic strength in tension:*—Steel, 30,000 lbs. per sq. in. Aluminum, 28,000 lbs. per sq. in. Ratio, 14 to 15, or 1 to 1.07.

Cross section for *equal* elastic strength in tension, see Figs. 6 and 8.

Weights:—For *equal* elastic strengths in tension, aluminum 0.356, steel 1, or 1 to 2.8.

2. *In compression.*

(*a*) *Ultimate strength of compression:*—Steel, 60,000; aluminum, 34,000. Ratio, 1 to 1.76.

Weights:—For *equal ultimate* strengths of compression, aluminum 1, steel 1.7.

(*b*) *Elastic strength in compression:*—Steel, 30,000 lbs. per sq. in. Aluminum, 26,000 lbs. per sq. in. Ratio, 1 to 1.15.

Weights:—For *equal elastic* strengths of compression, aluminum 1, steel 2.6.

3. *Ultimate strength in shear:*—Steel, 45,000 lbs. per sq. in. Aluminum, 28,000 lbs. per sq. in. Ratio, 1 to 1.6.

Weights:—For *equal ultimate* strengths of shear, aluminum 1, steel 1.875.

Double riveted joints:—Steel, 45,000 lbs. per sq. in. Aluminum, 24,000 lbs. per sq. in. Ratio, 1 to 1.875.

Summing up, for simple resistance, the comparison gives the following results:

1. For *ultimate tensile strength,* mild steel is half again as strong as the best aluminum alloy, but at the same time it is three times as heavy; in consequence, the same strength can be furnished by aluminum with half the weight that steel would require, or, with the same weight, aluminum would furnish double the strength.

2. For *elastic strength in tension,* aluminum is fourteen-fifteenths as strong as steel, and can supply the same elastic strength with but 0.36 of the weight required by steel; or, with the same weight, aluminum would furnish 2.8 times the strength.

3. For *ultimate strength of compression,* steel is 1.76 times as strong as aluminum, but to furnish the same strength would be 1.7 times as heavy.

4. For *elastic strength of compression,* aluminum is thirteen-fifteenths as strong as steel, and to furnish the same strength steel would be 2.6 times as heavy.

5. For *ultimate strength in shear,* steel is 1.6 times as strong as aluminum, and would be 1.875 times as heavy. When the shear is that of a riveted joint, where the riveting is double, steel is 1.875 times as strong. The lower performance of the double riveted joint would indicate for aluminum a less perfect co-operation among the rivets. As will be seen later, this is no doubt due to the very small elongation in the aluminum, which is no doubt the case for shear as it is for tension, causing the shearing more in detail, the rivets most strained giving way before there is

sufficient elongation to permit the full concurrence of the rivets less strained.

6. In sum, for *simple resistance*, from the standpoint of *strength* and *weight* alone, aluminum has pronounced advantages over steel, advantages that are nearly *double* for ultimate resistance, and nearly *treble* for elastic resistance.

This result emphasizes a striking feature of aluminum, namely, the very large proportion of its total strength that is elastic. While this proportion for steel is *half*, for aluminum it is seven-tenths.

The consequences of this remarkable property will be seen below in the comparison of resistance to dynamic forces; it will suffice for the moment to refer simply to the fact that the vast bulk of structural resistance must be elastic.

B.—Comparison for Compound Resistance.

For the present purpose, resistance to torsion need not be considered; moreover, there is lack of reliable data for the resistance of aluminum to torsion, and comparison would require an assumption of strength based upon the resistance to shearing. The comparison will therefore be limited to bending.

Recalling the formula, the bending moment,

$$M=\frac{sI}{h}, \qquad (1)$$

s being the stress per unit area of the fiber most strained, I the moment of inertia of the cross section, and h the distance of the fiber most strained from the neutral axis which passes through the center of gravity of the cross section.

Where the material has a different resistance for tension and compression, it is evident that with symmetrical cross sections, the fiber under the stress of the lesser kind of resistance will give way first, and would impose the limit to the bending moment.

It is also evident that the resistance of a given cross section for such a material is a maximum when the area is so distributed that the extreme fibers of tension and compression are distant from the neutral axis in the direct ratio of their respective resistances. When so distributed, the bending moment, $M=(s_c+s_t)\frac{I}{h}$, where s_c is the maximum resistance to compression, s_t the maximum resistance to tension, and h the entire depth of the beam.

In the cases of aluminum for ultimate resistance, the resistance to tension being 40,000 lbs. per sq. in., and the resistance to compression 34,000 lbs. per sq. in., the symmetrical section would have its limit imposed by the fiber under compression, and the ratio of the resistance of such a section to the resistance of a section designed to give a maximum resistance, if the moment of inertia is the same, is $\frac{34000}{\frac{40000 + 34000}{2}} = \frac{34}{37}$. For elastic resistance the ratio is $\frac{26000}{\frac{28000 + 26000}{2}} = \frac{26}{27}$.

With steel, however, the two resistances are the same and the symmetrical section realizes the maximum resistance.

The ratio $\frac{37}{34} = 1.09$ and $\frac{27}{26} = 1.04$ would represent the advantage to be derived from the best design for the aluminum section provided the moment of inertia did not change.

It is evident, however, that the transference of metal from the side of tension to the side of compression will result in placing this metal nearer the neutral axis and in consequence will reduce the moment of inertia. The two ratios, therefore, while remaining appreciably greater than unity, will be less than those indicated, 1.09 and 1.04, according to the form of the section.

Bearing in mind this small but appreciable discrimination against aluminum, it will suffice, for the sake of simplicity, to compare only symmetrical sections.

1. *Comparison of usual sections designed for resistance other than bending.*

(*a*) The case of *square cross sections* designed for *tension* or *compression.*

The ratio of bending moments, from equation (1), is

$$\frac{M'}{M} = \frac{s'}{s}\,\frac{I'}{I}\,\frac{h}{h'}, \qquad (2)$$

the letters with the affixes denoting aluminum.

If the side of the aluminum section is n times the side of the steel section, $h' = nh$, or $\frac{h}{h'} = \frac{1}{n}$.

The *areas* of the cross sections being in the ratio $\frac{h'^2}{h^2} = n^2$ and

the radii of gyration squared in the ratio $\frac{h'^2}{h^2} = n^2$, the moments of inertia are in the ratio $\frac{h'^4}{h^4} = n^4$ and $\frac{I'}{I} = n^4$,

$$\therefore \quad \frac{M'}{M} = \frac{s'}{s} \times n^4 \times \frac{1}{n} = \frac{s'}{s} n^3. \qquad (3)$$

Take first the case illustrated in Fig. 5, of (1) *section designed for equal ultimate tensile strength,* designating by S and S' the two ultimate tensile strengths.

$$h'^2 S' = h^2 S \text{ or } \frac{h'^2}{h^2} = \frac{S}{S'} \text{ or } n^2 = \frac{S}{S'} \text{ and } n = \sqrt{\frac{S}{S'}}.$$

Substituting in equation (3), $\frac{M'}{M} = \frac{s'}{s} \cdot \left(\frac{S}{S'}\right)^{\frac{3}{2}}$.

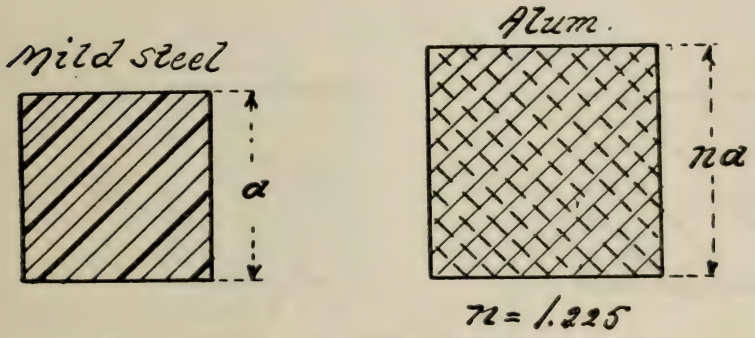

FIG. 5.—Section of Equal Ultimate Tensile Strengths.

Suppose first that the cross sections are worked to their limit of resistance to bending. It is the extreme compressed fibers of the aluminum sections which will break first when $s' = 34{,}000$ lbs. per sq. in. The fibers of the steel section resist equally for tension and compression, both attaining 60,000 lbs. per sq. in., so that $\frac{s'}{s} = \frac{34000}{60000}$. The two ultimate tensile strengths S and S' being 60,000 and 40,000 respectively,

$$\frac{S}{S'} = \frac{60000}{40000} \text{ and } \frac{M'}{M} = \frac{34000}{60000} \times \left(\frac{60000}{40000}\right)^{\frac{3}{2}} = 1.04.$$

Suppose next that the cross sections are worked only to the elastic limit of the most strained fibers.

The limit for the aluminum cross section is again imposed by the fibers of compression where $s' = 26000$.

For the steel section the limit being the same for both fibers, $s = 30{,}000$ $\qquad \frac{s'}{s} = \frac{26000}{30000}$.

S and S' being the same as before,

$$\frac{M'}{M} = \frac{26000}{30000} \times \left(\frac{60000}{40000}\right)^{\frac{2}{3}} = 1.6.$$

It does not suffice in general to know simply the *amount of resistance* to bending. It is also necessary to know the effect of the bending moment, the amount of deformation or deflection produced. It is therefore necessary to calculate the resistance to deformation, to know the stiffness. The measure of stiffness is the amount of bending or the deflection produced by a given force. The amount of deflection, $f = \frac{K}{E.I}$, where E is the modulus of elasticity, and I the moment of inertia of the cross

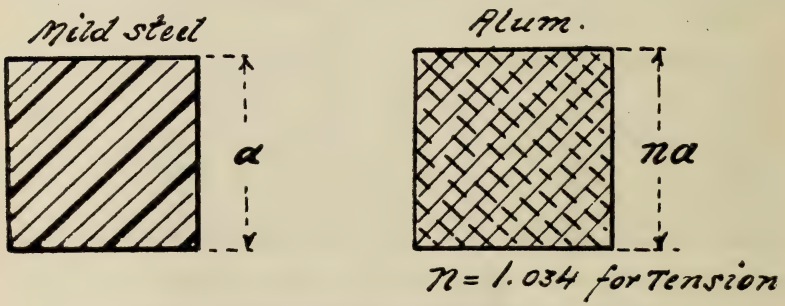

FIG. 6.—Section of Equal Elastic Strength in Tension.

section as above, K being constant under the same conditions of bending moment and support. Therefore, the conditions being the same,

$$\frac{f'}{f} = \frac{E.I}{E'.I'} \quad (5).$$

Taking the modulus of elasticity of aluminum as that given by Hütte, 10,000,000, and the modulus of steel as 30,000,000, $\frac{E}{E'} = 3$.

As seen above, for the case in question, $\frac{I}{I'} = \frac{1}{n^4}$, where $n = 1.225$, $\frac{I}{I'} = \frac{1}{2.25}$. Substituting in equation (5), $\frac{f'}{f} = \frac{3}{2.25} = \frac{1}{0.75}$. Thus, for square cross sections giving equal ultimate strengths in tension, the deflection produced by the same force under similar conditions of bending is greater in the case of the aluminum section. The square steel bar is one-third the stiffer.

(2). *Sections designed for equal elastic strength in tension,* illustrated in Fig. 6.

By a similar process of reasoning,

$$\frac{M'}{M} = \frac{34000}{60000} \times \left(\frac{30000}{28000}\right)^{\frac{3}{2}} = .627,$$

when worked to the ultimate limit.

$$\frac{M'}{M} = \frac{26000}{30000} \times \left(\frac{30000}{28000}\right)^{\frac{3}{2}} = .959,$$

when worked to the elastic limit.

$$\frac{f'}{f} = \frac{3}{1.143} = \frac{1}{.381}.$$

(3). *Sections designed for equal ultimate strength of compression.*

When worked to the ultimate limit, $\frac{M'}{M} = 1.328$

When worked to the elastic limit, $\frac{M'}{M} = 2.031$

$$\frac{f'}{f} = \frac{1}{1.032}.$$

(4). *Sections designed for equal elastic strength of compression.*

When worked to the ultimate limit, $\frac{M'}{M} = .703$

When worked to the elastic limit, $\frac{M'}{M} = 1.073$

$$\frac{f'}{f} = \frac{1}{.441}.$$

(5). *Sections of equal weight.*

When worked to the ultimate limit, $\frac{M'}{M} = 2.94$

When worked to the elastic limit, $\frac{M'}{M} = 4.50$

$$\frac{f'}{f} = \frac{1}{3}.$$

b. The case of rectangular cross sections designed for tension plates of a given width.

Refer to Figs. 7 and 8.

The areas of the cross sections are bh' and bh respectively, b being the *width*; the radii of gyration squared are in the ratio of $\frac{h'^2}{h^2}$.

Therefore, the moments of inertia are in the ratio of $\frac{h'}{h} \times \frac{h'^2}{h}$ $= \frac{h'^3}{h^3}$, and the bending moments are in the ratio

$$\frac{M'}{M} = \frac{s'}{s} \times \frac{h'^3}{h^3} \times \frac{h}{h'} = \frac{s'}{s} \times \frac{h'^2}{h^2} = \frac{s'}{s} \times n^2. \qquad (4)$$

(1). *Sections designed for equal ultimate strength.* Fig. 7.

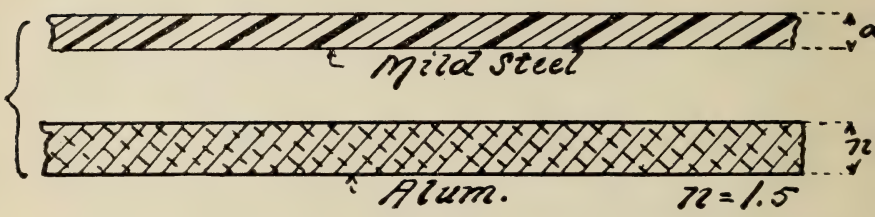

FIG. 7.—Plates of the same length and breadth and of Equal Tensile Strength.

When worked to the ultimate limit, $\frac{M'}{M} = 1.275$

When worked to the elastic limit, $\frac{M'}{M} = 1.94$

$$\frac{f'}{f} = \frac{1}{1.125}.$$

(2). *Sections designed for equal elastic strength.* Fig. 8.

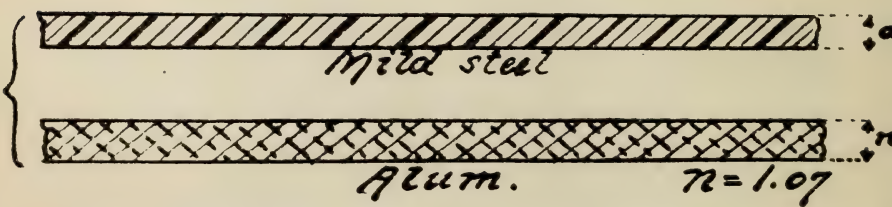

FIG. 8.—Plates of the same length and breadth and of Equal Elastic Strength.

When worked to the ultimate limit, $\frac{M'}{M} = .648$

When worked to the elastic limit, $\frac{M'}{M} = .99$

$$\frac{f'}{f} = \frac{1}{.408}.$$

(3). *Sections designed for equal weight.*

When worked to the ultimate limit, $\frac{M'}{M} = 5.1$

When worked to the elastic limit, $\frac{M'}{M} = 7.8$

$$\frac{f'}{f} = \frac{1}{9}.$$

2. *Comparison of sections designed for resistance to bending.*

a. Shapes having equal weight.

(1). I *Beams.* Fig. 9.

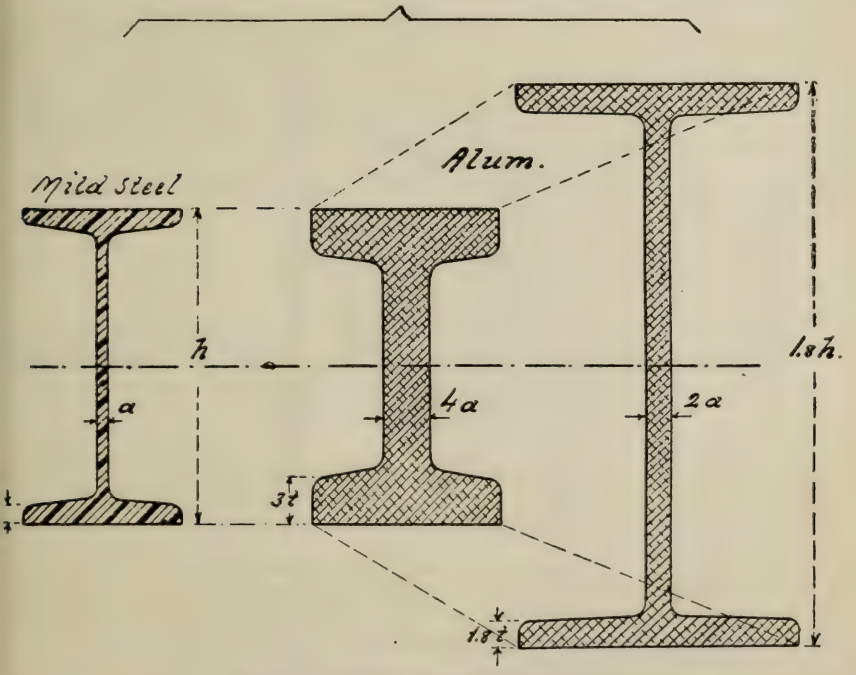

FIG. 9.—Sections of Equal Weight.

First, when the *depth* of I beams is limited, being the *same* for *both sections.*

Ratio of moments of inertia, $\frac{I'}{I} = 2.36$

When worked to the ultimate limit, $\frac{M'}{M} = 1.43$

When worked to the elastic limit, $\frac{M'}{M} = 2.05$

$$\frac{f'}{f} = \frac{1}{.786}.$$

Next when the depth is not limited, and the sections have proportioned dimensions.

Ratio of moments of inertia, $\frac{I'}{I} = 9.25$

When worked to the ultimate limit, $\frac{M'}{M} = 2.91$

When worked to the elastic limit, $\frac{M'}{M} = 4.45$

$$\frac{f'}{f} = \frac{1}{3.08}.$$

(2). Angle bars, ∠. Fig. 10.

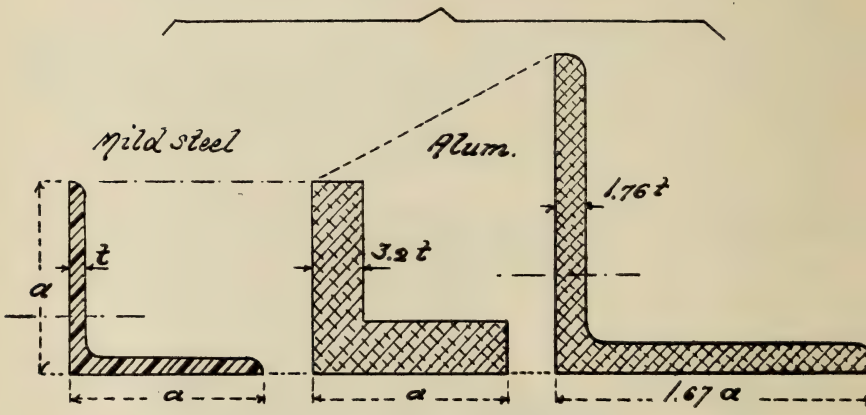

FIG. 10.—Sections of Equal Weight.

First when the depth of ∠ is the same.

Ratio of moments of inertia, $\frac{I'}{I} = 4.61$

When worked to the ultimate limit, $\frac{M'}{M} = 1.56$

When worked to the elastic limit, $\frac{M'}{M} = 2.4$

$$\frac{f'}{f} = \frac{1}{1.54}.$$

Next when the *depth is proportioned.*

Ratio of moments of inertia, $\frac{I'}{I} = 6.91$

When worked to the ultimate limit, $\frac{M'}{M} = 2.35$

When worked to the elastic limit, $\frac{M'}{M} = 3.59$

$$\frac{f'}{f} = \frac{1}{2.3}.$$

b. Shapes giving equal bending moments.

(1). I *Beams.* Figs. 11 and 12.

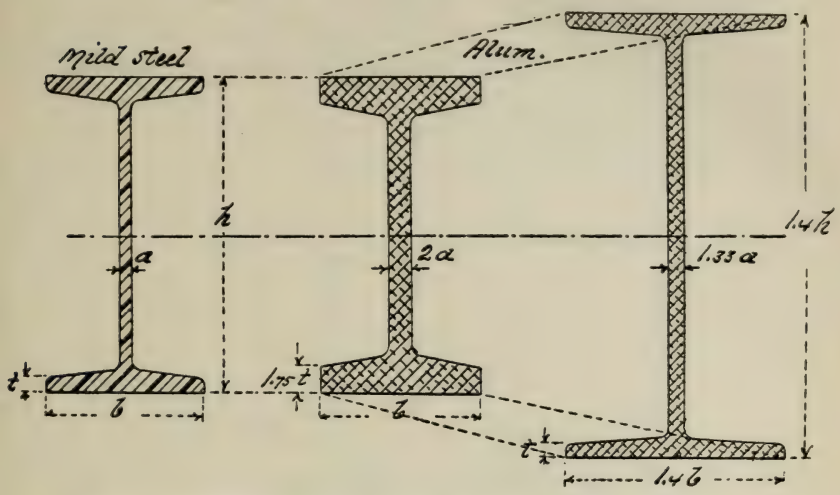

FIG. 11.—Sections for Equal Bending Moments. Fiber under ultimate compressive strength.

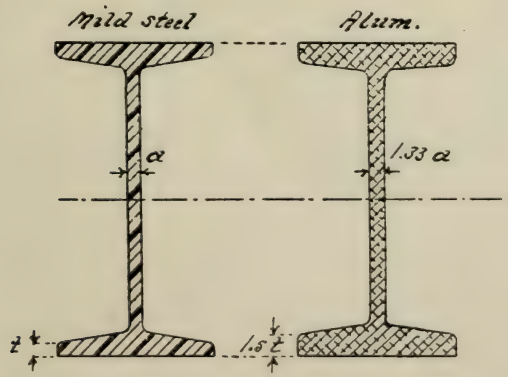

FIG. 12.—Sections for Equal Bending Moments. Fiber compressed to elastic limit.

First, when designed from the *ultimate limit of resistance.*

Fig. 11.—When the *depth* is the *same,* the ratio of cross sections is 1.67, the *ratio of weights is* 0.553 and $\frac{f'}{f} = \frac{1}{.59}$.

When the *depth is proportioned*, the ratio of cross sections is 1.39, the *ratio of weights* is 0.46 and $\frac{f'}{f} = \frac{1}{.82}$.

Next, when designed from *elastic limit of resistance.*

Fig. 12.—The *depth* being the *same*, the ratio of cross sections is 1.11, the ratio of *weights is* 0.37 and $\frac{f'}{f} = \frac{1}{.38}$.

(2). *Angle bars* $\angle$. Figs. 13 and 14.

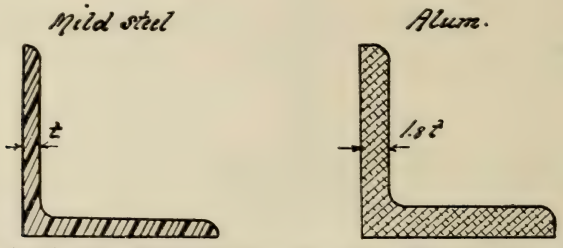

FIG. 13.—Sections for Equal Bending Moments. Fiber under compression worked to ultimate strength.

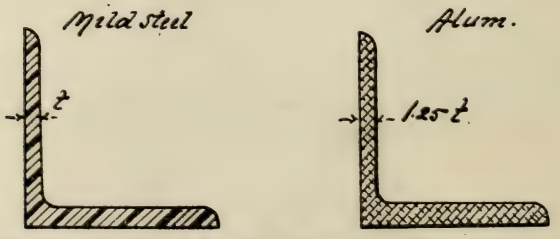

FIG. 14.—Sections for Equal Bending Moments. Fiber under compression worked to elastic limit.

When designed from the *ultimate limit*, the *depth* being the *same*, the ratio of cross sections is 1.74, the *ratio* of *weights* is 0.58 and $\frac{f'}{f} = \frac{1}{.58}$.

When designed from the *elastic limit*, the *depth* being the *same*, the ratio of cross sections is 1.19, the *ratio* of *weights* is 0.396 and $\frac{f'}{f} = \frac{1}{.38}$.

The above comparisons for resistance to bending and for stiffness give the following results, namely:

1. For bars of square section, giving the same ultimate tensile strength, the ultimate bending moment that each can resist is practically the same, the aluminum bar giving 1.04 times the resistance of the steel bar, while the bending moment before the elastic limit is reached is half as large again for aluminum, the ratio being 1.6. On the other hand, the steel bar is the stiffer of the two, the deviation or flexion produced by the same force being but three-quarters that of the aluminum bar. Thus the aluminum bar, giving the same ultimate tensile strength, an equal ultimate resistance to bending, three halves as great an elastic resistance to bending, of three-quarters the stiffness, weighs half as much as the steel bar.

2. For bars of square section, giving the same elastic strength in tension, the aluminum bar gives 0.6 the ultimate resistance to bending and 0.96 the elastic resistance to bending, is 0.38 only as stiff, but weighs about a third as much as the steel bar, $\frac{1}{2.8}$.

3. For bars of square section, giving the same ultimate strength of compression, the aluminum bar gives 1.33 times the ultimate resistance to bending, and 2.03 times the elastic resistance to bending, is about of equal stiffness and weighs about 0.59 as much as the steel bar.

4. For bars of square section, giving the same elastic strength of compression, the aluminum bar gives 0.7 the ultimate resistance to bending and 1.07 times the elastic resistance to bending, is but 0.44 as stiff and weighs about 0.38 as much as the steel bar.

5. For bars of square section of the same weight the aluminum bar, giving 2 times the ultimate resistance to tension, 2.8 times the elastic resistance to tension, 1.7 times the ultimate resistance to compression, 2.6 times the elastic resistance to compression, 1.875 times the ultimate resistance to shear, gives in addition 2.94 times the ultimate resistance to bending, 4.5 times the elastic resistance to bending and 3 times the stiffness.

6. For plates of rectangular sections of the same width, giving the same ultimate strength of tension, the aluminum plate, of half the weight, gives 1.26 times the ultimate resistance to bending, 1.94 times the elastic resistance to bending and 1.125 times the stiffness.

7. For plates of rectangular section of the same width, giving

the same elastic strength of tension, the aluminum plate, of about one-third the weight, gives 0.65 the ultimate resistance to bending, 0.99 the elastic resistance to bending, and 0.41 the stiffness.

8. For plates of rectangular section of the same width, having the same weight, the aluminum plate, giving twice the ultimate resistance to tension, 2.8 times the elastic resistance to tension, gives in addition 5.1 times the ultimate resistance to bending, 7.8 times the elastic resistance to bending, and 9 times the stiffness.

9. For I beams of the same weight and proportioned sections, the aluminum beam gives 2.83 times the ultimate resistance to bending, 4.45 times the elastic resistance to bending, and 3.1 times the stiffness.

10. For angle bars of the same weight and proportioned sections the aluminum angle gives 2.35 times the ultimate resistance to bending, 3.59 times the elastic resistance to bending, and 2.3 times the stiffness.

11. For I beams of proportioned sections, giving the same ultimate resistance to bending, the aluminum beam has 1.39 times the area of cross section, has 0.46 the weight and 0.82 the stiffness.

12. For I beams of the same depth, giving the same elastic resistance to bending, the aluminum beam has 1.11 times the area of cross section, 0.37 the weight and 0.38 the stiffness.

13. For angle bars of the same depth, giving the same ultimate resistance to bending, the aluminum angle has 1.74 times the area of cross section, 0.58 the weight and 0.58 the stiffness.

14. For angle bars of the same depth, giving the same elastic resistance to bending, the aluminum angle has 1.19 times the area of cross section, 0.39 the weight and 0.38 the stiffness.

Of the above results, whose applications to marine construction are pointed out below, the most striking and most significant are those indicating the possibilities of strength with limited weight.

Thus, for equal weight, in the case of square sections not designed primarily for bending, whose simple resistance as seen is about twice as great for aluminum for the ultimate limit and nearly three times as great for the elastic limit, the resistance to bending is nearly three times as great at the ultimate limit and four and a half times as great at the elastic limit, with three times the stiffness.

This advantage of greater resistance to bending and greater stiffness, thus pronounced for square sections, is enormously greater for plating. With the same weight the aluminum plate offers over five times the ultimate resistance to bending, nearly eight times the elastic resistance to bending, and is nine times as stiff.

These remarkable results flow from the great moment of inertia in the case of aluminum sections, the metal added to supply the increase of area of cross section acting with large leverage about the neutral axis. The aluminum plate being three times as thick, the moment of inertia is twenty-seven times as great. This enormous increase in stiffness, as will be seen below, is of great advantage in the case of thin plates, which are necessarily deficient in stiffness.

When resistance to bending and stiffness are themselves the objects of design, determining a form of section of large moment of inertia, with the usual shapes, such for instance as I beams and angle bars, the advantages offered by aluminum are more pronounced than in the cases of simple resistance. With equal weight it may be said broadly that the aluminum beam gives two and a half times the ultimate resistance and is two and a half times as stiff. The effect of aluminum's high fraction of elasticity is again striking; when compared for elastic resistance the aluminum beam gives about four times the strength.

Inversely, to produce a given ultimate resistance to bending the aluminum beam has about half the weight, though it is not quite so stiff, and to produce a given elastic resistance the aluminum beam has less than four-tenths the weight, but is only half as stiff.

The above comparisons for simple resistance and for resistance to bending and stiffness, all so heavily in favor of aluminum, are not complete, however, for passing upon the two metals from the standpoint of strength, for the forces implied are statical or else are applied gradually, while in the actual service of usual structures, particularly marine structures, the forces are dynamic and are applied with full effect from the start. The comparison to be complete must therefore extend to resistance to dynamic forces.

C.—Comparison for Resistance to Dynamic Forces.

Movement, wherever found, represents energy and is the result of work done, and its destruction requires antagonizing energy, antagonizing work. A force, however great, unaccompanied by movement, generating no energy, doing no work, could extinguish no energy of movement. To extinguish energy, the antagonizing force must retreat, and the amount of energy extinguished results not only from the magnitude of the force, but also from the distance of its retreat. If the resisting force varies in magnitude, the antagonizing work done is the integral of the products of the successive forces by the elementary distances, or is equal to the product of the mean force by the distance.

For comparing the resistance to dynamic forces of steel and aluminum it is thus necessary to determine or compare the mean force or resistance that each offers and the distance through which the resistance acts. Taking for the purpose of the comparison the case of tension, the force within the elastic limit starting at zero is proportional to the extension, so that the mean force up to the elastic limit is equal to half the force at the limit. This gives for steel a mean force of 15,000 pounds per sq. in., and for aluminum a mean force of 14,000 lbs. per sq. in. The elastic extension for mild steel being taken at ⅛ of one per cent, the work done within the elastic limit is $15000 \times 0.00125 = 18.7$ foot pounds per square inch of cross section for each foot of length.

Data is lacking on the direct measurement of the elastic extension of aluminum, but according to Hütte, referred to above, the modulus of elasticity of aluminum is 10,000,000. The modulus for mild steel being taken at 30,000,000, the same force would produce three times more elongation in aluminum. If the elastic limit reached 30,000 lbs. per sq. in., the elongation would be ⅜ of one per cent. Reaching only 28,000 lbs. per sq. in., the actual elongation would be $\frac{28}{30} \times \frac{3}{8} = \frac{7}{20}$ of one per cent. The work done, therefore, within the elastic limit is $14000 \times 0.0035 = 49$ foot pounds per square inch of cross section for each foot of length. The work done within the elastic limit per unit area of cross section is therefore 2.61 times greater in aluminum than in steel, as illustrated in Fig. 15. With the same weight the work done by the aluminum piece, which would have three times the area of cross section, would be 7.83 times as great.

When it is recalled that structures, particularly marine structures, are subject to repeated dynamic forces, which on account of their repetition must be extinguished within the elastic limit, since they would entail destruction if this limit were passed; when it is recalled, thus, that the bulk of usual structural resistance is resistance to dynamic forces within the elastic limit, the above remarkable result takes on the aspect of a most serious advantage, an advantage for aluminum that is overwhelming where the structure is not liable to be subjected to an unusual or extraordinary force. When, however, a single, unusual force is liable to be brought to bear, as frequently the case in marine structures,

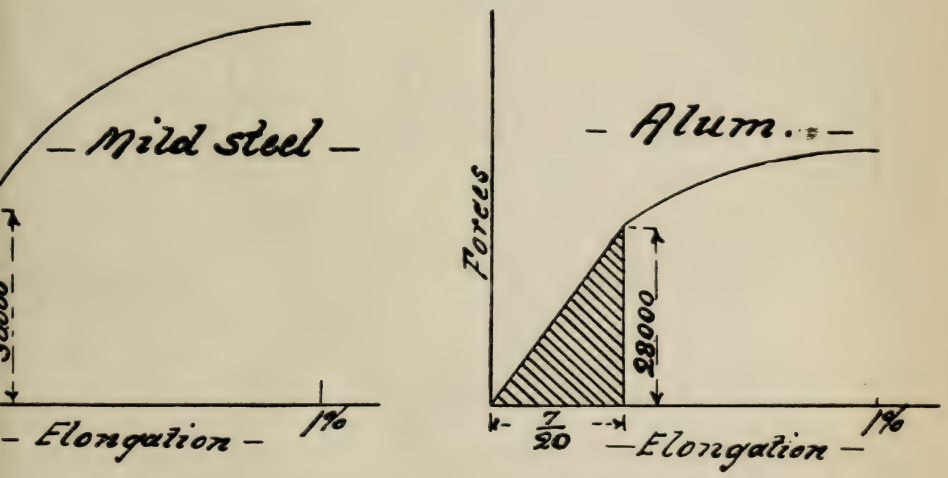

FIG. 15.—Extinction of Dynamic Forces. Work done within elastic limit.

causing the resisting material to pass its elastic limit, the aspect changes completely, for at the elastic limit the possible work of aluminum is nearing its limit while the work of steel has scarcely begun. Aluminum gives but ten per cent elongation in two inches, and practically no elongation outside of the two inches containing the fracture, while mild steel gives readily twenty-five per cent elongation in eight inches, and the elongation extends to parts far removed from the point of fracture. Thus when the elastic limit is passed, the bulk of the aluminum piece ceases to lend adequate additional assistance, throwing same upon the narrow region of ultimate fracture, while with steel the whole bulk of the piece continues to contribute proportionately to the end.

It is almost as though the whole volume worked with steel, while only a section worked with aluminum, and the ratio of the two is roughly proportional to the length. For pieces of even moderate length the difference in work done is enormous, as illustrated in Fig. 16. Thus against a single, isolated, abnormal, destructive dynamic force, steel gives an overwhelmingly larger

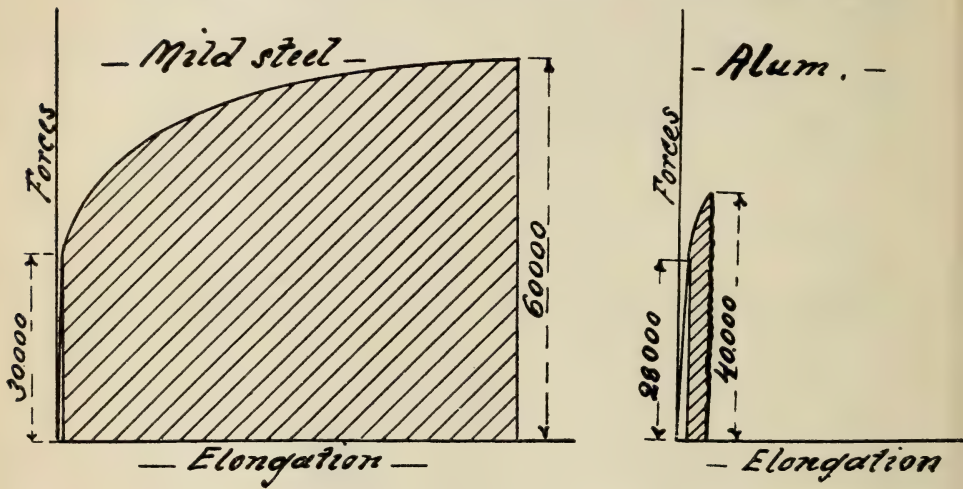

FIG. 16.—Work done beyond Elastic Limit.

Data for Curves, Figs. 15 and 16.	Mild Steel.	Alum.
Modulus of elasticity,	30,000,000	10,000,000
Elastic limit,	30,000 lbs.	28,000 lbs.
Elongation within elastic limit,	$\frac{1}{8}$ of one %	$\frac{7}{20}$ of one % (deduced from modulus of elast.)
Ultimate tensile strength,	60,000 lbs.	40,000 lbs.

Work done within the elastic limit, $W = \frac{1}{2} \frac{S^2}{E} \times V$, the ratio of work done.

S = lbs pr. sq. in. at elastic limit,
E = Modulus of elasticity,
V = Volume of body,

is thus, $\frac{\frac{30000^2}{30000000}}{\frac{28000^2}{10000000}} = \frac{30}{78.4} = \frac{1}{2.61}$.

guarantee, but for usual dynamic forces, liable to be indefinitely repeated, aluminum offers enormous advantages.

The application of the results of the above comparisons of advantage and disadvantage from the standpoint of strength and weight are treated below, but these alone are not final in determining the choice between two metals; another important factor enters, namely, cost.

(*To be concluded in No. 83.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ON THE PERFORATION OF FACE-HARDENED ARMOR.

By CLELAND DAVIS, Ensign, U. S. Navy.

In the following article the writer has endeavored to briefly summarize a theory of the resistance of face-hardened armor and the action of projectiles, both plain and capped, on impact, with the further object of presenting perforation formulas derived from experiments at Indian Head.

Prior to the advent of face-hardened armor formulas for the penetration of wrought-iron and homogeneous steel plates were based on the assumption that the projectile experienced no change of form while passing into and through the target. With face-hardened armor, however, such a thing rarely happens under the conditions of test except when the plate is far outmatched by the projectile, as when the projectile is of extraordinary quality, or the plate decidedly inferior.

As the result of experience in the United States it is not believed that a good formula based upon anything but complete perforation can be constructed to express the relation between gun and plate on impact, when the latter is face-hardened. In homogeneous plates the penetration is always proportionate to the energy of impact, and the resistance offered is largely local, closely corresponding to the action of punching. The action of resistance is radically different with face-hardened armor. The inextensibility of the hard face and its inability to bend or flow transmits the strain of impact to the tough back, and distributes it over a considerable area, thus bringing to bear all the resisting power of that portion of the plate to check the advance of the projectile. If the projectile has sufficient remaining energy pene-

tration ensues, otherwise the projectile smashes harmlessly on the plate. The first effect is to elastically dish the hard face; when the limit of strain is reached this gives way, and the resistance then becomes largely local; hard jagged fragments of the surface are carried into the body of the plate, scoring and abrading the ogival of the projectile and impeding its advance. The further function of the hard face is to prevent the flow to the front of displaced metal of the plastic body. Sometimes, when the projectile remains undeformed and the hard face is circumferentially broken to a diameter considerably greater than the caliber of the projectile, a front fringe appears around the shot hole; this of course decreases the total resistance to penetration.

It will thus be seen that the function of the hard face is threefold, of which the first mentioned is by far the most important. There is a definite limit of velocity corresponding to a considerable proportion of the total energy required for perforation, below which the projectile makes practically no impression on the plate, except perhaps a saucer-like depression enclosed by fine concentric cracks in the hard face. A 5-inch Carpenter projectile with a striking velocity of 1522 f. s. hardly marred the surface of a Carnegie 4-inch plate, while a velocity of 1977 f. s. just effected perforation. An 8-inch Holtzer projectile, striking a Bethlehem 10-inch plate at a velocity of 1498 f. s., failed to break the hard face.

The theory of the resistance of face-hardened armor, now generally accepted in this country, was first enunciated by Lieut. A. A. Ackerman, U. S. Navy, and his deductions have been fully borne out by subsequent experiments. It seems to be the popular impression that the resisting power of armor due to the action of the hard face is derived from its power to fracture the shot's point, with a subsequent smashing and pulverizing progressively from the point.

It is difficult to see how this theory can be reconciled to the results of the great number of experiments conducted in this country. On such an hypothesis disintegration of the projectile must commence the instant the point reaches the face, and the successive layers or particles of metal shearing and sliding over one another and the whole breaking into a myriad of fragments, thus distributing the remaining energy among the particles and rendering the aggregation powerless to do harm. When partial

penetration is effected some of these fragments are supposed to act together as a unit, combining their energy—the whole mashing into the indent and forming a coherent mass that remains sticking in the plate.

On impact the following cases represent the action of the projectile depending upon the caliber of gun, thickness of plate, weight of projectile, quality of projectile and plate, and striking velocity:

1. Where complete perforation is effected, the projectile remaining intact or only slightly deformed. In nearly every instance where the projectile is upset, the diameter is increased around the bourrelet, and where there are signs of rupture cracks appear extending parallel to the axis emanating evidently from the upset portion, and forming ribbon-like strips evenly distributed around the circumference. 2. Sometimes a section of the plate is punched out to a diameter equal to or slightly exceeding the caliber of the projectile, the shell being broken up and part of the head remaining apparently welded into the face of the section punched out. (This is not usual in the United States where the plate is just perforated, though from the reports it seems to occur abroad, especially in Germany, in almost every instance where bare perforation ensues.) In this country the plate usually gives way in the rear by rupture along lines radiating from the center of the back bulge. Sometimes the punched-out section is found intact, and this usually occurs when the plate is much overmatched. The punched-out section is then nearly always in the form of an obtuse cone. 3. Where the head remains sticking in the plate. Sometimes, but rarely, the point and ogival remain undeformed, but usually the ogival is mashed into a mushroom-like mass, breaking away the shot-hole to a diameter sometimes 50 per cent larger than the caliber of the projectile; this is caused by its upsetting at or near the bourrelet. The apex of the powder chamber is invariably preserved when the penetration is appreciable. 4. Where the projectile rebounds, being shattered on impact, or remaining intact or slightly deformed. In the latter case the same effect is observed as when perforation occurs, namely, bulging at the bourrelet with a tendency to rupture along longitudinal lines extending through the bourrelet.

Often the point is broken or sheared off when the impact is not normal. It is rare that the axis of the projectile is normal to the

tangent plane of the surface at the moment of impact. Even when striking at a considerable angle the projectile turns and enters the plate normally, following the line of least resistance. It is this lateral component of the blow at an angle to the axis that causes the breaking off of the point, the projectile often remaining otherwise undeformed after perforation or rebounding. The fracture in such cases is always clean, with no evidence of a sliding motion over one another of the particles, showing that in the case of perforation the point is carried through the plate, becoming detached afterward. Occasionally, when the projectile is of excellent quality, but the velocity unequal to perforation, the head of the projectile remains sticking in the plate apparently undeformed. A Krupp face-hardened plate exhibited at the World's Fair at Chicago in 1893 showed this strikingly. The back bulge on this plate was so cracked as to show the point plainly visible and apparently perfect in form.

The action of the projectile on impact with regard to rupture may be stated as follows: The first tendency is to bulge at or near the bourrelet; this is due to longitudinal compression and is what would be expected. At the moment of impact the greatest strain is on the point, but this does not give way locally, being in the first place superior in quality to the metal of the plate (and this latter would therefore give way first where the energy is sufficient to effect penetration at all), and in the second place being supported by the form of the ogive, which may be compared to an arch of which the point is the top. The strain is thus transmitted to the body of the projectile, which causes it first to bulge and then to crack longitudinally in response to the transverse component of the blow. When the head effects an entrance and the plate is not perforated, the hard envelope of the ogival is usually flaked off and the more plastic metal of the interior is moulded into a mushroom-like mass, not rupturing because of the support of the metal of the plate. Sometimes, however, the tempered surface of the ogive remains intact. This rarely occurs in partial penetration, but is nearly always the case when complete perforation ensues, all parts of the projectile getting through the plate. In the latter event when rupture occurs, the head breaks up along its weakest lines.

Finally, in all cases, fragments found either in front or in rear of the plate present clean fractures, except where the pieces are

evidently marred by contact with the plate; the lines of fracture of the body are at right angles and parallel to the axis, and the exterior surface of the fragments (except in the cases cited before, where the hard envelope of the ogive is flaked off) shows that there was little or no deformation before rupture.

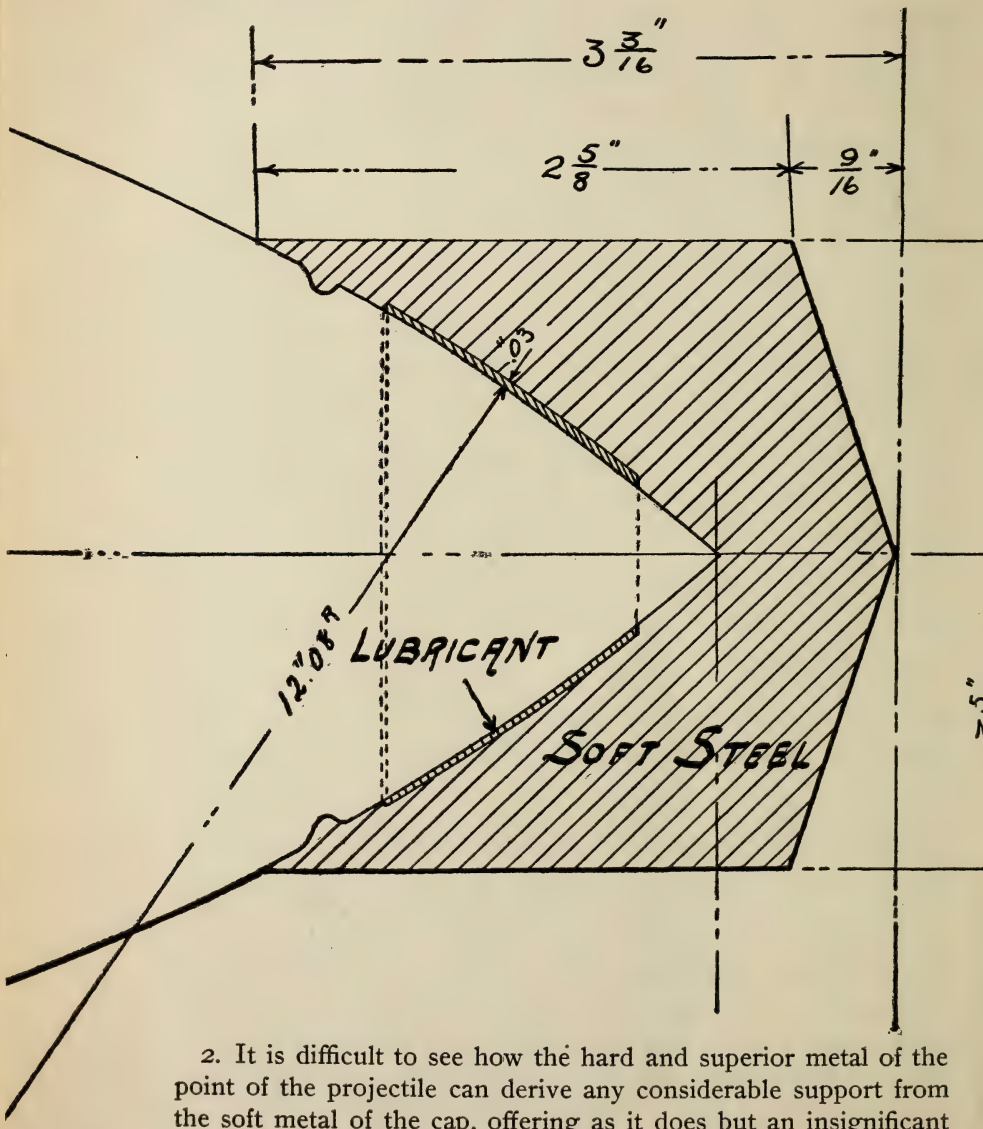
In effect the concentrated resistance presented by the face-hardened plate checks the advance of the projectile, and the sudden stoppage causes the latter to break up along its weakest lines through its own inertia.

As to the advantages of a soft steel cap fitted over the point of the projectile. Many experiments have been carried on by the Bureau of Ordnance with various forms of caps presented by Mr. Isaac G. Johnson and with some of its own devising, and the results have so uniformly demonstrated the superiority of projectiles so fitted in the penetration of face-hardened armor that the Department has decided to fit them to all service projectiles. A tabular list of all these experiments is appended to this article and reference will be made to this table further on. The cap, as adopted, consists of a cylindrical piece of soft steel, half the caliber of the projectile in diameter, bored out to a depth of two-thirds its length to fit over the head of the ogival. A recess or cavity in the interior surface, .03 of an inch deep, contains a lubricating material. The sketch shows a service cap fitted to a six-inch projectile.

Several theories have been advanced to explain the action of this cap on impact. 1. Some hold that it acts as it were a buffer against the hard and impenetrable face of the plate, preventing the sudden stoppage of the projectile and greatly lessening the shock of impact. 2. The main claim of the patentee, Mr. Johnson, is in effect that the cap, completely surrounding and enclosing the point of the projectile, as it does, strengthens the projectile by supporting it all around, thus giving increased resistance to lateral deflection and to longitudinal compression.

It is believed that neither one of these theories offers the true explanation. The fallacy of the first becomes apparent when it is considered that if the function of the cap is merely to lessen the shock of impact, the same results could be achieved by firing a projectile without a cap at such a reduced velocity that it will strike the plate at the same velocity as the capped projectile had after piercing the cap. In other words, unless the cap in some

manner weakens the plate or strengthens the projectile it can only reduce the velocity with which the point of the projectile meets the face of the plate.



2. It is difficult to see how the hard and superior metal of the point of the projectile can derive any considerable support from the soft metal of the cap, offering as it does but an insignificant resistance to longitudinal and transverse strains. Certainly it cannot resist materially the compressive strains due to impact.

Possibly the cap may be a slight aid to the point in preventing it from being broken off when the impact is oblique, but it is believed that the cap is disintegrated in this case before the shearing strain comes on the point. This theory was no doubt derived from the supposition that projectiles crush progressively from the point. If the cap is ruptured, as would seem to be the case, before the point of the projectile reaches the face of the plate, the cap would operate merely to reduce the striking velocity.

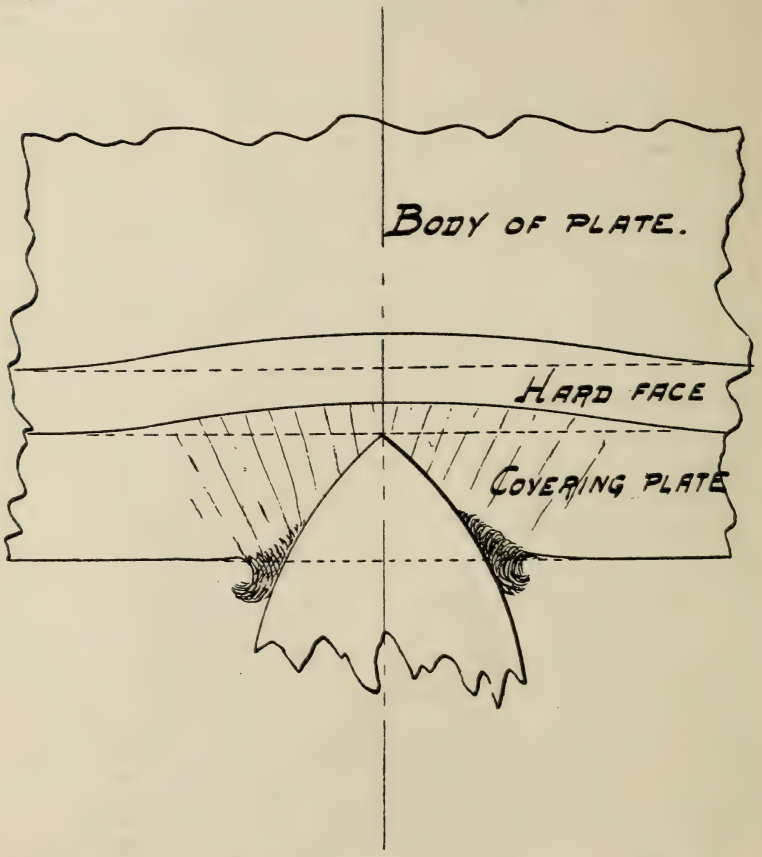
The true explanation of the action of the cap must be taken in conjunction with the theory of the resistance of face-hardened armor enunciated before. The cap, meeting the face of the plate at a high velocity, dishes or depresses the hard surface to the limit of its elasticity, the cap being itself destroyed in so doing. And to be effective, therefore, the cap must have sufficient stiffness or longitudinal strength to accomplish this; possibly the hard face is crushed in by this action. The projectile meanwhile is advancing, its way through the cap being smoothed by the lubricant, and when the point meets the plate resistance to its advance is purely local. Possibly the passage of the projectile through the plate is facilitated by the carrying in of sufficient of the lubricant and portions of the soft cap to cover asperities in the metal and prevent the hard jagged fragments of the face from scoring and abrading the surface of the ogival. This, it is believed, is the true function of the cap. The comparative ease with which face-hardened armor is perforated when a thin plate of wrought iron is placed over the surface, as shown by Russian experiments, can be readily explained on this theory, by considering the wrought-iron metal opposed to the point of the projectile at the moment of impact to bear the same relation as the cap to the point of the projectile. The action is explained in the following somewhat exaggerated sketch (see next page):

The point of the projectile enters the wrought-iron plate and the stress of impact is transmitted to the hard face along lines normal to the ogival, depressing the surface to the limit of its elasticity, so that when the point reaches the plate, although its velocity is reduced, the resistance it encounters is not concentrated but is local. The breaking in of the hard face by the superior metal on the point of the projectile is then comparatively an easy matter.

Various forms of these caps have been tried at Indian Head

with more or less definite results. The following, however, seem to be conclusively established:

1. That a projectile fitted with a solid cap of the form finally adopted, but containing no lubricant, is superior to an uncapped projectile.



2. That a cap in the form of a hollow cylinder with thick walls, containing no lubricant, is equally as efficient as the solid cap containing no lubricant. This goes far toward proving the theory that the effect of the cap is to weaken the plate rather than strengthen the projectile.

3. That a thin-walled envelope filled with lubricant does not facilitate penetration.

4. That the most effective form is a thick-walled cap or envel-

ope, strong enough to withstand considerable strain before rupture, yet plastic enough to permit of some deformation before breaking, combined with a lubricant contained in a recess or cavity surrounding the point of the projectile. Soft steel seems to be the best material for the cap, though experiments have shown copper to be very efficient.

In the *London Engineer* of July 3rd, 1896, there is an article entitled, "Herr Krupp on the Perforation of Steel Armor," in which is mentioned a formula recently propounded by Krupp as applicable to the perforation of the best and newest plates with hardened faces. The original formula given in continental units is $p\ v^2 = 5800\ a\ e^2$, where v is the striking velocity in meters, p the weight of the projectile in kilos, a the diameter of the projectile in cm., and e the thickness of the plate in cm. Translated into English units this formula becomes

$$e^2 = \frac{pv^2}{a} \frac{1}{\log^{-1} 6.3532}$$

Certainly, the writer says, this is the simplest and oldest form of Fairbairn's equation. As originally deduced, based upon statical experiments, by punching iron plates under the machine, using cast, wrought and steel punches with round and flat ends, and starting with the hypothesis that the work expended by a shot in piercing a plate was equal to the striking energy, his formula was of the form $e^2 = \frac{pv^2}{a} \cdot C$, which is identical with the above.

According to Krupp, continues the writer, we may now take it as based on the best formula that can at present be suggested. And being founded on correct principles, the formula will no doubt be fairly accurate if the constant is changed to meet changed conditions so long as the projectile is assumed to pass into and through the target unbroken and undeformed.

Experiments ranging over a period of several years, comprising the attack of face-hardened armor by guns of all service calibers up to and including the 13-inch, have been carried on by the Bureau of Ordnance, under the direction of Captain W. T. Sampson, U. S. Navy, at the Naval Ordnance Proving Ground at Indian Head. The similarity of conditions in these experiments, in quality of armor and projectile, of gun and charge, furnishes reliable data from which a formula can be evolved that will

express with fair accuracy the relation between the perforating power of the projectile and the resisting power of the plate.

A table is appended giving the details of those experiments that were chosen as being of a thoroughly representative character. In a large majority of these cases where perforation ensues the energy of the projectile was just sufficient to overcome the resisting power of the plate, completing perforation with but slight surplus energy, the plate cracked possibly and the projectile set up, deformed or disintegrated, the pieces lodging in the backing or in the butt. In a great many cases reservation must be made due to the weakening of the plate from previous impacts.

It might here be stated that where plate and projectile are practically evenly matched, being of good quality, both are strained nearly to the limit of rupture, and when this occurs either in one or the other it does not mean a considerable increase in the consumption of energy beyond that taken up by the strains of impact. Assuming, then, an equation of the form $e^x a^y C = p V^2$, it will readily be seen that such indeterminate elements as the cracking of the plate, breaking up of the projectile, dissipation of energy in the form of heat, can, by considering the absorption of energy in these ways to bear the same proportion in all cases to the total striking energy, be included in the constant. This equation is fundamentally sound. It was first elucidated by Fairbairn on the hypothesis that the destructive power of a shot was due to its energy, and has since formed the basis of all formulas for the penetration or perforation of armor.

Having, then, data deriving considerable reliability from similarity of conditions, it becomes easy to evolve a formula that will express within limits, allowing for difference in quality of plate and projectile, the results of the laws of destruction, though of course such an expression being empirical, the laws themselves cannot be definitely stated.

By the method of least squares the most probable values of the exponents and of the constant were found to be contained in the following expression:

$$V = \frac{a^{\frac{1}{2}} e^{\frac{3}{4}}}{p^{\frac{1}{2}}} \log^{-1} 3.345\,12,$$

where V = striking velocity in foot seconds;
a = caliber of gun in inches;
e = thickness of plate in inches;
p = weight of projectile in pounds.

As before stated this formula expresses the relations between the elements only when perforation ensues. From it can be determined the minimum velocity sufficient to perforate a plate of given thickness, or the maximum thickness of plate that can be perforated by a projectile of given velocity. The non-deformation of the projectile is not assumed, but the formula is based on data where the energy of the projectile was barely sufficient to accomplish perforation, the projectile being broken up and the pieces passing through the plate.

Perforation Table.

(Calculated from the above formula.)

Gun.	Plate.	Velocities.
4″	3	1757
	4	2180
5″	4	1980
	5	2343
	6	2683
8″	8	1884
	9	2058
	10	2227
	11	2392
12″	12	1696
	13	1801
	14	1904
	15	2005
	16	2104
	17	2202

Gun.	Plate.	Velocities.
6″	5	1813
	6	2078
	7	2333
	8	2579
10″	10	1760
	11	1891
	12	2019
	13	2143
	14	2266
	15	2386
13″	13	1648
	14	1742
	15	1834
	16	1925
	17	2015
	18	2103

This table now forms the basis from which the velocities for acceptance tests of armor and of projectiles are obtained.

It is believed that this formula represents, with as much accuracy as could be expected in an empirical expression, the present status of the relation between armor and projectile in the United States.

In this connection it is interesting to compare the results of some of the latest trials abroad, especially those of Krupp, with experiments in this country, and by means of the formula they can be reduced to a definite basis, with reservations allowing for differences in quality of plate and projectile. It is to be regretted that there are but meagre data relative to experiments on face-hardened armor in England and France that will serve for comparison as to relative merit. England has only lately come to

adopt nickel steel armor for general use, and the recent ballistic trial of a 6-inch plate representing a lot of armor for the Canopus type shows this plate to be up to the average for that thickness. As yet, however, they have gone no further.

In Germany there are records of many experiments against plates of different thicknesses, which, while not so extensive as those made in the United States, are still sufficient to give a fair idea of comparative value. There is no question but that Krupp armor is at least the equal of if not superior to that of England, France, Austria and Russia. Experiment indicates the latter; hence the other countries will not suffer if Germany is taken as the European representative in comparing the quality of American armor with that made abroad.

Some of Krupp's most recent experiments are tabulated and appended with columns showing the velocities required for perforation under the same conditions calculated from the proposed formula and from the one quoted before as being that presented or used by Krupp. The agreement in the former case with the actual results is striking. The velocities given by the Krupp formula seem to be entirely at variance with the actual results for the thicker plates; too much value is given to slight variations in thickness of plate. Captain Castner, however, states in an article published in "Stahl und Eisen" in April, 1896, referring to the Krupp formula: "Whether this formula can also be applied to thick plates is, according to the assertion of the Krupp works, still unsettled, as such plates have not yet been perforated."

These experiments of Krupp with the larger plates were evidently conducted with the view of obtaining the actual velocities required for the perforation of the plates. The truly remarkable agreement of the calculated with the actual velocities as given by these experiments shows that much reliability can be given to the proposed formula as a basis for comparing the resisting qualities of German and American armor. An examination of the tabulated results of these experiments at Indian Head, upon which the formula is based, carried on during a period of several years, shows a constant and steady improvement in the quality of Carnegie and Bethlehem armor. Attention is called to the Bethlehem 8-inch plate, manufactured for the Maine's turret and tested October 2, 1894. As regards resistance, the best service plate yet tested was a Carnegie 12½-inch reforged, face-hardened plate,

B. 491, manufactured for the forward 13-inch B. L. R. barbette of the Kearsarge.

The plate had previously been attacked by two 10-inch Holtzer A. P. shell, the second of which made a diagonal crack 5 feet long and 7 inches deep in the back of the plate. This plate was attacked by a 12-inch Carpenter projectile weighing 850 lbs. with a striking velocity of 1932 f. s. and a striking energy of 21,940 tons. The back bulge was driven out, but no part of the projectile, which broke into 79 pieces, got through the plate. This velocity under similar conditions would, by the formula, have sufficed for the perforation of a 14.3-inch plate. The projectile, as stated by the Inspector of Ordnance, gave every indication of being an excellent one. The plate was through cracked and broken into three pieces, lines of fracture radiating from this impact and passing through place of impact No. 2.

By the formula, using the weight of a Krupp or St. Chamond 12-inch A. P. projectile, 716 lbs., a plate of the thickness of 14.3 inches requires a velocity of 2107 f. s. to perforate, which, in the experiments on plate 575-A, was shown to be just sufficient for the perforation of a plate 13.78 inches thick. This latter plate seems to have been more resisting than its companion 14.49-inch plate, 575-B, and slightly superior to the average of American plates as shown by the formula. Therefore the 12.5-inch Carnegie plate would seem to be equal in resistance to a 13.78-inch Krupp plate. There are several considerations, however, that must be taken into account affecting the final comparison of superiority. The Krupp plate was experimental and no doubt manufactured with the utmost care with the view of obtaining the most resisting plate; the Carnegie plate was chosen from a lot of twenty-two as promising to make the poorest showing ballistically of all. On the other hand, the Carnegie plate was practically destroyed, being cracked and broken into three pieces, while the Krupp plate was not through cracked, being indeed hardly cracked at all; such cracks as did develop being confined practically to the surface, and radiating from the point of impact to the edges. The greatest depth of these cracks was about two inches. Again, the greater weight of the Carpenter projectile is no inconsiderable factor even though the energy of impact in both cases is the same.

Weighing these considerations, then, it would seem that the Carnegie and Krupp plates were of about equal merit, the super-

ior resisting power of the one being balanced by the greater toughness and tenacity of the other.

The most resisting plate that Krupp has yet produced is the 11.8-inch plate tested at Meppen in September, 1895. This plate withstood the impact of a Krupp 712.6 lb. A. P. projectile with a striking velocity of 1993 f. s., being practically uninjured save three surface cracks, the greatest depth of which was 3.1 inches. The plate was not perforated; the depth of penetration was not given, but from the fact that the back bulge was 3 inches high and slightly cracked it would appear that the limit of resistance had been almost reached. A Carnegie 12-inch experimental reforged face-hardened plate, tested at Indian Head on May 29, 1897, compares very favorably with this star plate of Krupp. The Carnegie plate was 12 feet long, 8 feet wide and 12 inches thick, and was backed by 12 inches oak and two ½-inch skin plates, the backing being secured to the plate by 18 2.8-inch armor bolts. In shape the plate was flat, rectangular. It was attacked first by a 12-inch Holtzer A. P. projectile weighing 850 lbs., striking with a velocity of 1811 f. s. The impact was 6 feet 2 inches from the right edge and 3 feet 8 inches from the bottom; the point of the projectile just perforated the back bulge, punching out an attenuated hollow cylindrical section that was driven through the backing and fell in rear of the plate. The surface of the plate was dished ⅝-inch over an area corresponding to a diameter of about 3.5 feet; diameter of flaking, 21 inches; diameter of shot-hole, 13½ inches, the interior being quite rough. The plate showed no signs of cracking. The projectile broke up, some of the pieces getting through, but the bulk falling in front of the plate. This projectile appeared to be of very good quality. It was evident that the plate and projectile were nearly evenly matched, and that with a slightly decreased velocity the projectile would have been defeated. A second round was then fired, using an 850-lb. Wheeler-Sterling projectile, striking velocity, 1769 f. s.; striking energy, 18440 f. s.; location of impact, 3 feet from left edge and 3 feet from the bottom. The projectile smashed on the plate, a portion of the head remaining stuck in the impact. The surface of the plate around the impact was dished and flaked as usual. There were no signs of cracking.

Now, by the formula, the Krupp plate should be perforated by a 12-inch 712.6-lb. projectile with a velocity of 1829 f. s. It with-

stood, however, a velocity of 1993 f. s. The Carnegie plate by the formula should be perforated by a 12-inch 850-lb. projectile with a velocity of 1696 f. s.; it was just defeated by a velocity of 1811 f. s. On the face of it, using the proportion

$$\overline{712}^{1/2}\ (1993 - 1829) = \overline{850}^{1/2}\ (x - 1696),$$

the Carnegie plate, to have been equal to the Krupp plate (the relative quality of the projectiles not being considered), should have defeated an 850-lb. projectile at 1846 f. s. It must be remembered, however, that the angle of impact in the instance of the Krupp plate was 9° from the normal, while in the case of the Carnegie plate the impact was exactly normal; the former plate was slightly cracked after three impacts, while the latter showed no signs of cracking after two rounds. All in all, it may fairly be said that this Carnegie plate is fully as good as that of Krupp.

As to the relative value of the qualities, hardness and toughness, opinions differ. In the development of the art of manufacture of face-hardened armor Krupp seems to have taken the maximum of the latter as the objective point with the greatest amount of hardness consistent therewith; while in this country resistance to penetration has been the prime object. The writer is of the opinion that a degree of hardness could well be sacrificed to increase toughness. The armor makers, however, having reached such a high standard of resistance, are pardonably loath to give up even a modicum of it, and are now striving to increase the toughness and still retain the excellence of resisting power to which they have attained, with encouraging hopes of success, as shown by the experiment described above.

The foregoing remarks apply to the thicker plates; the thinner plates, German and American, seem to possess similar qualities of resistance, both as regards hardness and toughness, with a slight advantage, if any, in favor of the American plates.

The adoption of soft steel caps fitted over the points of projectile has taken away at least 15 per cent from the efficiency of face-hardened armor. The following formula, tentative through lack of sufficient data, especially for the larger calibers of gun and plate, to support its reliability, is proposed for the perforation of face-hardened armor by capped projectiles. The velocities given by this formula agree fairly well with such experiments as

have been made, as will be seen by reference to the appended table.

$$V = \frac{a^{\frac{1}{2}} e^{\frac{4}{5}}}{p^{\frac{1}{2}}} \log^{-1} 3.25312$$

Using the same units as before:

VELOCITIES FOR THE PERFORATION OF FACE-HARDENED ARMOR BY CAPPED PROJECTILES.

Gun caliber.	Plate thickness.	Velocity. f. s.
4″	3″	1467
	4	1890
5″	3	1333
	4	1717
	5	2052
	6	2375
	7	2687
8″	7	1520
	8	1691
	9	1858
	10	2022
	11	2182
	12	2339
12″	12	1554
	13	1656
	14	1758
	15	1857
	16	1956
	17	2053
	18	2149
6″	4″	1330
	5	1590
	6	1840
	7	2081
	8	2315
	9	2544
10″	10	1598
	11	1725
	12	1849
	13	1971
	14	2092
	15	2211
13″	13	1515
	14	1608
	15	1699
	16	1789
	17	1878
	18	1966

Following is a table showing thickness of face-hardened armor that would be perforated at different ranges by capped projectiles and projectiles without caps, fired with the velocities given by smokeless powder and striking normally under favorable conditions:

PERFORATION OF FACE-HARDENED ARMOR, WITHOUT BACKING.

Gun Caliber In.	Muzzle			1,000 Yards			1,500 Yards			2,000 Yards			2,500 Yards		
	Muzzle Velocity	Capped Projectile	Uncapped Projectile	Remaining Velocity, f. s.	Capped Projectile	Uncapped Projectile	Remaining Velocity, f. s.	Capped Projectile	Uncapped Projectile	Remaining Velocity, f. s.	Capped Projectile	Uncapped Projectile	Remaining Velocity, f. s.	Capped Projectile	Uncapped Projectile
5	2600	6.7	5.8	2134	5.3	4.4	1934	4.7	3.9	1752	4.1	3.4	1587	3.6	3.0
6	2500	8.9	7.7	2169	7.4	6.3	2020	6.7	5.7	1881	6.1	5.2	1752	5.6	4.7
8	2400	12.3	11.0	2169	11.0	9.7	2063	10.3	9.0	1961	9.6	8.4	1864	9.0	7.9
10	2350	16.1	14.7	2172	14.7	13.2	2088	14.0	12.5	2007	13.3	11.8	1929	12.6	11.2
12	2400	20.7	19.1	2245	19.1	17.4	2171	18.2	16.7	2099	17.5	16.0	2030	16.8	15.3
13	2400	23.1	21.4	2259	21.4	19.8	2191	20.6	19.0	2126	19.8	18.3	2064	19.1	17.6

The tremendous advantages of the higher caliber guns and heavier projectiles is apparent. The sustained velocity and destructive effect due to the weight of the projectile are factors of prime importance. No armor has yet been made that can withstand the terrible blow of a 13-inch shell, fired with a muzzle velocity of 2400 f. s. (which will hereafter be the service velocity, using smokeless powder), and striking normally within a range of 2500 yards. The value of the 8-inch gun may be clearly seen, and arguments for its retention in future battle-ships should be convincing.

The tendency abroad has been to decrease the thickness of armor, the caliber of guns and the weight of projectiles for the different calibers, a curious reaction from the policy in vogue not many years ago when equality between gun and armor was maintained by increasing the power of the former and the thickness of the latter, the quality of both armor and projectile undergoing steady improvement.

The adoption of the face-hardened process almost simultaneously, in this country at least, with the use of nickel in the steel, has resulted to the present time in an increase in efficiency over homogeneous steel armor of 80 per cent for thin plates, 4 or 5 inches in thickness, ranging to about 45 per cent for the very thick plates, and an increased efficiency over oil-tempered nickel steel armor of at least 35 per cent on an average. The advent of the cap has, however, reduced this lead to 20 per cent. The importance of the latter, therefore, must be appreciated, especially as caps can be cheaply fitted to the armor-piercing projectiles now in service.

The logical projectile so far as the power of perforation goes is undoubtedly the solid shot, but its advantage in this regard over shell is more than outweighed by the destructive effect of the latter, due to its breaking up after perforation, especially as armor-piercing shell can now readily be burst after piercing a considerable relative thickness of armor, equal, say, to the caliber of the projectile.

Maker and kind of Metal.	Date of Trial.	Place of Trial.	Dimensions.			Shape.	Projectile		
			Length.	Width.	Th'kness.		Cal.	Wt.	V
Carnegie, nickel steel. (Mass. 8″ B. L. R. Barbette)	April 2, '94.	Indian Head.	21′ 8″ .5	5′ 3″ .5	6″	Curved rad., 9′ 7″	6″	100	2
" " "	"	"	No. 6	without	b'ki'g.	.....	6″	100	2
" " "	"	"	7	"	"	.....	6″	100	1
Bethlehem, nickel steel. (Mass. 18″ B. L. R. Barbette)	June 12, '94.	"	12′ 1″	7′ 7″	17″	Curved rad., 15′ 10″	12″	850	1
Carnegie, nickel steel. (Mass. 8″ B. L. R. Barbette)	May 10, '94.	"	21′ 8″	5′ 3″ .5	6″	" 8′ 9″	6″	100	1
" " "	Oct. 2, '94.	"	21′ 8″	5′ 3″ .5	6″	" "	6″	100	2
" " "	"	"	21′ 8″	5′ 3″ .5	6″	" "	6″	100	2
" " "	"	"	21′ 8″	5′ 3″ .5	6″	" "	6″	100	1
" " "	"	"	21′ 8″ .5	5′ 3″ .5	6″	" "	6″	100	2
Bethlehem, nickel steel. (Maine's turret)	"	"	15′ 2″	5′ 3″ .75	8″	" 11′ 9″	8″	250	2
Carnegie, nickel steel. (Oregon's 13″ B. L. R. Barbette)	July 12, '94.	"	13′ 1″	8′ 8″	17″	" 15′ 10″	12″	850	1
Carnegie, nickel steel. (Oregon's 2d 13″ Barbette)..	Dec. 15, '94.	"	12′ 1″	8′ 5″	17″	"	12″	850	1
" " "		"	12′ 1″	8′ 5″	17″	"	12″	850	1
Carnegie, nickel steel. (Experimental reforged)....	Feb. 24, '95.	"	179″	102″	14″	Flat.	10″	500	1
" "		"	179″	102″	14″	"	12″	850	1
" "		"	"	"	"	"	12″	850	1
" "	Mar. 29, '95.	"	"	"	"	"	12″	850	2
" "	April 1, '95.	"	"	"	"	"	12″	850	2
Carnegie, nickel steel. (Oregon's side)	Oct. 8, '95.	"	90⅝″	42″	18″ for 4′ to 8″ at bot.	Rectangular, tapered.	12″	845	1
Bethlehem, nickel steel. (Oregon's 13″ turret, and Iowa's diagonal)	May 13, '95.	"	21′ 8″	7′ 2″	12″ at top to 7″ at bot.	Plain rectangular, tapered.	13″	1100	1
" "		"	"	"	"	"	13″	1100	1
" "		"	"	"	"	"	13″	1100	1
Bethlehem, nickel steel. (Mass. side)	Sep. 23, '95.	"	21′ 8″	7′ 2″	14″ .4 at imp.	Rect. tapered.	13″	1100	1
Carnegie, nickel steel. (Experimental reforged.) Iowa's 8″ B. L. R. Barbette	April 27, '95.	"	17′ 3″	4′ 8″	14″ .4 at imp.	"	13″	1100	1
Carnegie, nickel steel. (Experimental reforged.) Iowa's 8″ B. L. R. Barbette		"	"	"	6″	Unbacked, flat rectangular.	6″	100	2
Carnegie, nickel steel. (Oregon's side, 2d half.....	May 17, '95.	"	"	"	"	"	6″	100	2
			.....	.....	18″	Rect. tapered.	13″	1100	1
Carnegie, nickel steel. (Comparative test of two plates similar to competition test, plate sent to Russia)	May 25, '95.	"	frag 8′	ment of 5′	plate of im 10″	16″ thick pact. Flat rectangular.	13″ 8″	1100 251	1
			Left	hand	Frag	ment.	8″	251	2
							8″	250	2
Carnegie, nickel steel. Iowa's side armor, also of simplified and shorter bolts and section of framing representing Iowa's side.	Sept. 4, '95.	"	16′ 0″	7′ 5½″	14″	Flat tapered.	12″	850	1
Carnegie, nickel steel. (Iowa's side armor).....	Sept. 17, '95.	"	"	"	"	"	13″	1100	1
Carnegie, nickel steel. (Iowa's 8″ turret)	Feb. 12, '96.	"	19′ 2″	4′ 8″	7″	Curved.	6″	100	2
							6″	103	2
							6″	103	2

nd kind of ctile.	Penetration.	Effect on Projectile.	Effects on Plates.
er special.	18″ into backing.	Broke up.	Uncracked.
	Through.	"	No cracks, one fragment of shell fell through hole.
	4″ Estimated.	"	One through crack.
	15″ "	"	One fine crack to edge.
	2″ .7	"	Uncracked.
	4″	"	"
-Sterling	4″ .5	"	Uncracked, back bulge broken out.
	4″	"	Uncracked.
-Sterling	Through.	"	Old cracks opened.
mond.	2″ into backing.	"	Cracked into four pieces.
-Sterling.	Through all.	Point abraded.	Uncracked.
"	9″ .5	Broke up.	Cracked through from each impact to upper edge.
er.	9″ .5	"	Cracked through horizontally from No. 1 to lower edge.
	9″ .5 Estimated.	Head held in plate, remainder rebounded in fragments.	Flaked to diam. 24″.
-Sterling.	Through plate and backing.	Recovered whole, 1″ of point gone.	Slight flaking, hole smooth.
er.	" " "	Broke up	Diam. of hole 14″ .5, plate cracked from top to bottom.
-Sterling.	" " "	"	Shot hole clear and smooth.
"	" " "	"	Cracked through.
solid steel, ap.	9″ Estimated.	Broke up, head of shot fused and imbedded in shot hole.	Through cracks to top of impact, Nos. 1 and 2.
er.	Through plate and backing.	Recovered entire.	Dished 2″, cracked through.
	9″ Estimated.	Broke up into large number of pieces, head welded in hole.	Left end broke off, cracked, splashed and flaked.
	8″ "	Broke up.	Left hand upper portion broken away, through cracks.
	Through plate and backing.	Fragments lodged in sand butt.	Cracked from top to bottom.
	" " "	" " "	
-Sterling.	Point just through.	Broke up.	Uncracked.
er.	4″ Estimated.	Broke up into small pieces, head remained in plate.	Through crack to impact No. 1. Back bulge broken out and smashed into sand butt.
-Sterling.	10″ to 12″	Broke up, all pieces passing through backing, recovered in sand butt.	Probably gave way before penetration was complete, right hand portion of plate and backing completely wrecked, all armor bolts displaced.
-Sterling, hell.	7″ Estimated.	Broke up in small pieces, welded in hole.	This fragment broke into four pieces, separated from backing, and thrown to ground.
	6″ .5 "	Broke up, head fused into impact.	Right hand plate flaked and dished, cracked from impact to top.
-Sterling.	7″ .25 "	Broke up into small pieces, head welded into impact.	Through crack to left edge, flaked.
er.	7″ .25 "	Broke up, head welded into plate.	Left hand plate, through crack to bottom.
-Sterling.	17″ Point through plate.	Broke up below bourrelet.	Through cracked from top to bottom through impact, other cracks not through.
"	Through plate and backing.	Point fused, but projectile otherwise entire.	Uncracked.
"	3″ .75	Broke up, head welded in plate.	Through crack in left side of plate, splashed and flaked.
solid steel, ap.	4″ .5 Estimated.	" " "	Practically same effect as in previous round.
"	5⅜″	" " "	Further through cracks, flaked.

Maker and kind of Metal.	Date of Trial.	Place of Trial.	Dimensions.			Shape.	Proje	
			Length.	Width.	Th'k-ness.		Cal.	W
Carnegie, nickel steel. Reforged (for Russian Govt.) R. 12	Mar. 26, '96.	Indian Head.	12′ 9″	8′ 7″	5″	Warped.	5″	5
Carnegie, nickel steel. Reforged (for Russian Govt.) representing lot 2. R. 44	May 16, '96.	"	12′ 9″	8′ 7″	8″ top to 4″ bot.	Warped.	6″	10
Carnegie, nickel steel. Reforged (B. 122½)	May 27, '96.	"	17′	5′ 6″	8″	Flat rectangular. (Unbacked.)	8″	25
" "	"	"	"	"	8″	"	8″	25
" "	"	"	"	"	8″	"	8′	25
" "	May 29, '96.	"	"	"	8″	"	8″	25
" "	"	"	"	"	8″	"	8″	25
Carnegie, nickel steel	June 4, '96.	"	17′ 1″	3′ 9″	13″	Unbacked. Flat rectangular.	12″	85
" "	June 17, '96.	"	17′ 1″	3′ 9″	13″	"	12″	84
" "	"	"	17′ 1″	3′ 9″	13″	"	12″	84
Carnegie, nickel steel. Face-hardened, reforged, B. 122½	"	"	17′	5′ 6″	8″	Flat rect.	8″	25
Carnegie, nickel steel	.....	.....	17′	5′ 6″	8″	"	8″	25
							8″	25
Carnegie, nickel steel	July 1, '96.	"	16′ 8″	5′ 5″ .5	8″	Unbacked. Flat rectangular.	8″	25
" "	July 17, '96.	"	16′ 8″	5′ 5″ .5	8″	"	8″	25
" "	"	"	16′ 8″	5′ 5″ .5	8″	"	8″	25
" "	"	"	16′ 8″	5′ 5″ .5	8″	"	8″	26
" "	"	"	16′ 8″	5′ 5″ .5	8″	"	8″	25
" "	Aug. 19, '96.	"	Fragment of above.			"	8″	25
" "	Oct. 8, '96.	"	"	"	"	"	8″	25
" "	Aug. 21, '96.	"	17′	8′	13″	"	12″	85
" "	"	"	"	"	13″	"	12″	85
Bethlehem, nickel steel. (Texas side)	Sept. 18, '96.	"	16′	7′ 6″	12″	Flat, tapered.	12″	85
	"	"	"	"	12″	"	12″	85
" "	Oct. 21, '96.	"	"	"	12″	"	12″	85
Carnegie, nickel steel	Sept. 15, '96.	"	Fragment		8″	Flat rectangular.	8″	25
" "	Oct. 30, '96.	"	.. ....	.....	12″	Unbacked.	12″	85
" "	Nov. 10, '96.	"	.....	.....	12″	"	12″	85
" "	Nov. 17, '96.	"	Fragment		12″	"	12″	85
" "	Nov. 12, '96.	"	"	"	12″	"	12″	85
" "	Nov. 23, '96.	"	"	"	8″	"	8″	85
Carnegie, nickel steel. (B. 491 Kentucky's barbettes)	Dec. 29, '96.	"	8′ 2″	12′ 10″	12″ .5	Curved.	12″	85
Carnegie, nickel steel. (B. 480, Kearsarge for'dside)	Feb. 12, '97.	"	21′ 4″	7′ 6″	4″	Flat.	5″	5
Bethlehem, nickel steel. (8337 B, conning tower shield, Kentucky)	May 8, '97.	Redington.	11′ 5″	5′ 7″	10″	Curved.	8″	25
Carnegie, nickel steel. Experimental	May 29, '97.	Indian Head.	12′	8′	12″	Flat.	12″	85
"	"	"	"	"	"	"	"	85

and kind of jectile.	Penetration.	Effect on Projectile.	Effects on Plates.
er-Sterling.	2″	Broke up, point welded in impact.	Small crack in back bulge, the triangular piece in upper right hand corner 16″x 10″ broke off, splashed and flaked.
er A. P.	7″	Broke up, point and portion of bourrelet welded in impact.	Plate uncracked.
ler A. P. No. ceptance test nting lot 1).	3″ .5	Broke up on plate, portions of head and point welded in impact, shell reduced to small pieces, almost the entire shell being broken up completely.	Plate dished .50″ at impact, no cracks.
le A. P. Extal No. 248.	7″	Portion of head welded into impact, remaining portion rebounded, cracked from base to bourrelet through middle.	Diam. of hole 8″.5. Diam. of splash and flaking 15″. Back bulge 4″ high, 15″ diam. Plate through cracked from impact to right edge. A surface crack developed, extending 24″ to left and above impact.
le A. P. Extal No. 333.	8″ .5	Rebounded to front, shortened 6″ .5 and upset to a diam. of 8″ .75 at bourrelet, body normal 7″ from base, point gone, with head fused and scarred.	Diam. of hole 8″. Depth 9″. Diam. of splash and flaking 16″. Back bulge 3″ .5 high, broken out to a diam of 9″. Diam. of back bulge 21″.
nter A. P. No. ceptance test nting lot 13).	4″	Broke up, head to for'd edge of bourrelet welded into impact, body of shell broken into ten pieces.	Dished 1″ at impact and over 48″ diam. Back bulge 2″ .25 high. Surface cracks.
nter A. P.	Through plate.	Broke up.	
ler-Sterling	"	Broke up into 72 pieces.	Back bulge broken out cone shaped, upper right hand corner broken off.
ler-Sterling	"	Practically uninjured.	Right hand lower corner broken off, horizontal through cracks.
nter.	"	Broke into 33 pieces.	Right hand portion broken off.
enter A. P.), 3d accept-	6″	Broke up on impact, 21 pieces recovered, head welded in impact.	Two through cracks through old impact.
ler A. P. (Lot acceptance.	8″	Broke up, point welded into impact, 23 pieces recovered.	Through cracks to No. 7.
"	7″	Broke up, point welded into impact, 15 pieces recovered.	Through cracks vertically from top to No. 17, thence to No. 10.
ler-Sterling.	Through plate.	Uncracked, 1″ .39 point gone.	No cracks.
"	"	Uncracked, base broke off.	"
ler-Sterling	"	Went through.	"
ler-Sterling mental.	"	Penetrated plate and broke up.	Back bulge 17″ broken out all around.
ler-Sterling mental A. P.	"	Broke up, 49 pieces recovered.	Plate badly cracked.
nter.	"	Projectile cracked but not broke up.	Right hand portion detached.
'	"	Broke into 26 pieces.	
ler A. P.	"	Broke into large number of pieces.	Plate through cracked, 2 fragments detached.
"	"	Recovered entire.	Plate completely demolished, fragments scattered.
"	"	" "	Through cracked, corner detached.
"	"	Recovered, broken into 6 pieces.	Through cracked, pieces detached.
nter.	"	Broken into 34 pieces.	Plate cracked, right hand portion wrecked.
	"	" " 15 "	Usual flaking, and back bulge broken out.
ler.	Through except 6 sm. pieces.	Broken into large number of pieces.	Fragment broken off corner, cracked.
nter.	" " 6 "	" " " "	Through cracked, pieces detached.
	Through.	" " " "	Plate completely wrecked.
ler.	"	" " " "	Fragment completely wrecked.
nter.	"	Broken into 127 pieces, all through.	No cracks.
enter.	10″ .5	Smashed, fragments remaining in front of plate.	Back bulge broken out in cone shaped mass, and driven into target structure. Plate broken into 3 pieces.
	Point just through.	Broke up, half its length fell in front of plate, head broke through plate and buried itself in the backing.	Uncracked. Back bulge broken out in shape of obtuse cone, having base 24″ in diameter, and lodged in backing.
This shot was rify the velocity e formula, which			
er.	10″	Broke up, head striking in plate.	Uncracked, usual flaking, dished ¼″.
er.	Through.	Broke up, small pieces getting through, major portion remaining in front of plate.	Uncracked. Dished ¼″. Back bulge broken out in form of cyl. section, and driven into and through backing.
ler-Sterling.	Unknown.	Uncracked, fragment remaining in front of plate.	Uncracked.

DATE OF TRIAL.	CHARACTER OF PLATE.	PREVIOUS IMPACTS.
1894		
March 12.....	Carnegie, nickel steel, Harveyized. 8′x6′2″x12″ flat. Backing 2′ Oak.	
April 12.....	Carnegie, nickel steel (Brooklyn's side), 13′x8′6″x3″. Backing 24″ thick.	3 impacts with Carpenter 4″ A. P. projectile at velocities and 1800 f. s., respectively, failed to perforate. Plate uncra
July 12.....	Carnegie, nickel steel, Harveyized. 13′ 1″ x 8′ 8″ x 17″ Curved rad. 15′ 10″. Backing 3′ Oak.	(1.) Carpenter 12″ A. P. shell at 1410 f. s., penetrated 15″ an whole, no cracks in plate. (2.) Wheeler-Sterling 12″ A. P. shell at 1858 f. s., went throu backing, whole, no cracks in plate. (3.) Carpenter 12″ A. P. shell at 1858 f. s., broke up after pen one through crack in plate. (4.) Carpenter 12″ A. P. shell at 1858 f. s., broke up after pen former cracks opened up. (5.) Midvale 10″ A. P. shell at 1983 f. s., rebounded whole, ably set up, penetration 20″, several new cracks in plate. (6.) Midvale 10″ A. P. shell at 1983 f. s., rebounded, much se torted, penetration 12″ .5, another through crack in plate.
July 20.....	Bethlehem, nickel steel, Harveyized. 16′ 7″ .5x7′ 6″x18″ flat. Thickness uniform over 4′ of width, then tapering to 8″ at bottom. Backing 3″ Oak.	(1.) Carpenter 12″ A. P. shell at 1465 f. s., broke up, penetra cracks in plate. (2.) Carpenter 12″ A. P. shell at 1926 f. s., broke up, penetra through crack. (3.) Wheeler-Sterling 12″ A. P. shell at 1926 f. s., broke up, 15″, additional cracks.
Oct. 2.....	Carnegie, nickel steel. Mass. 8″ B. L. R., barbette. 21′ 8″x 5′ 3½″x6″. Curved, unbacked.	8 impacts at various velocities with Carpenter and W. S. 6′ no perforations.
1895		
Feb. 12 . . .	Carnegie, nickel steel, Harveyized, reforged. 17′6″x4′8″x7″ curved. Backed by 24″ Oak.	(1.) Carpenter A. P. shell at 1620 f. s., smashed on plate, pe plate uncracked, (2.) Wheeler-Sterling A. P. shell at 1816 f. s., smashed on pl tion 3″, plate uncracked.
April 27.....	Carnegie, nickel steel, Harveyized, reforged. 17′ 3″x4′ 8″x6″ flat. Unbacked.	(1.) Wheeler-Sterling 6″ A. P. shell at 2100 f. s,, broke up, set up and fused, point just through plate. (2.) Carpenter 6″ A. P. shell at 2100 f. s., broke up, head plate, penetration about 4″.
May 5	Carnegie, nickel steel, Harveyized, reforged. 8′x6′x10″ flat. Backed with 12″ Oak and 3 mild steel plates, ½″ thick.	8″ Carpenter A. P. shell at 2064 f. s., projectile smashed, p from impact to top.
1896		
March 11.....	Carnegie, nickel steel Exp. Backed with 12″ Oak. 11′ 2″x8′ 7″. Thickness 5″ at bottom, tapering to 3.5″ at top.	8 impacts with Carpenter and W. S. 4″ projectiles. S cracks developed but plate otherwise uninjured.
May 5	Carnegie, nickel steel, Harveyized, reforged. 17′6″x4′8″x7″ curved. Backed with 12″ Oak.	
May 9	Bethlehem, nickel steel, Harveyized. 13′ 3″ .5 x 5′ 9″ .5 x 15″. Curved to a rad. of 14′ 4″. Backed by 8″ Oak and 2 ½″ mild steel plates.	(1.) Carpenter 10″ A. P. shell at 1539 f. s., smashed, penet cracks in plate. (2.) Carpenter 10″ A. P. shell at 1940 f. s., smashed, penet cracks. (4.) 12″ W.-S. shell at 1701 f. s. Penetrated 11″.5 and broke u crack from impact No. 3 to bottom of plate.

E-HARDENED ARMOR.

PROJECTILE.	STRIKING VELOCITY.	RESULT.
on 10" shot, soft steel weight 500 lbs.	1600 f. s.	Projectile broke up, penetration 9", plate wrecked.
er-Sterling shell, fitted Johnson soft steel cap.	1700 . s.	Perforated; broke up; no cracks.
on 10" shot, soft steel weight 500 lbs.	1983 f. s.	Projectile penetration 20", and remained sticking in plate with base broken off, very little distortion, cracks in plate opened up further.
on 10" shot, soft steel weight 500 lbs.	1983 f. s.	Projectile rebounded, broken into five large pieces, very little distortion, penetration 15" .6, broke fragment out of plate.
.-S. shell, fitted with son cap.	1900 f. s.	Perforated; projectile whole; plate uncracked.
.-S. shell, fitted with son cap.	1700 f. s.	Perforated; projectile whole; plate uncracked.
on 6" shot, soft steel cap, ht 100 lbs.	2100 f. s.	Projectile went through plate and backing, and was found in butt with point broken off, but otherwise uninjured, plate uncracked, hole through plate smooth.
on 6" shot, with soft steel weight 100 lbs.	2100 f. s.	Projectile went through plate and backing, and was found in butt with head broken off, but otherwise uninjured, hole through plate smooth.
on 6" shot, soft steel cap, ht 100 lbs.	858 f. s.	Projectile smashed on plate, practically no penetration.
on 6" shot, soft steel cap, ht 100 lbs.	2100 f. s.	Projectile went through plate, 24" oak and 8' of earth, and was found entire, uncracked and very little upset.
on 6" shot, soft steel cap, ht 100 lbs.	2100 f. s.	Projectile went through plate, 24" oak, 9' of earth, and was found entire and uncracked, except flaked off at base.
on 6" shot, soft steel cap, ht 100 lbs.	2100 f. s.	Projectile went through plate, 24" oak and 10' of earth, and was found very little upset and uncracked, but with a transverse fracture through band score.
on 6" shot, soft steel cap, ht 100 lbs.	2100 f. s.	Projectile went through plate, 24" oak and 10' of earth, and was found entire, uncracked and practically undistorted.
on 6" shot, soft iron cap, ht 100 lbs.	2100 f. s.	Projectile penetrated 7" into plate and broke off transversely at bourrelet, the ogival remaining imbedded in plate in one piece, and the rear body rebounding. The diameter of rear body was increased 6" .11, but otherwise the projectile seemed undistorted. Old cracks in plate opened somewhat.
on 6" shot, soft steel cap, ht 100 lbs.	2505 f. s.	Projectile went through plate and backing, and was found 8' in sand, but entire, except that half of base was broken off diagonally to the band score. Two small longitudinal surface cracks on body, diameter increased to 6" .11 and length increased 0" .49, hole through plate 6⅛" diameter, and mostly smooth, no further cracks in plate.
.-S. shell fitted with son cap.	1711 f. s.	Perforated; lodged in backing, breaking up. Plate not cracked.
on 6" shot, soft steel cap, ht 100 lbs.	2100 f. s.	Line of fire 21° from normal to plate, projectile broke up after penetrating 5", the pieces rebounding, no projectile metal adhered to impact, back bulge broken out from plate and forced into the backing, plate cracked through impact.
on 6" shot, Aluminun ze cap, weight 100 lbs.	2100 f. s.	Normal impact, projectile went through plate, backing, target structure, and was found 8" in butt, entire, and but slightly distorted, hole through plate smooth, plate badly cracked.
on 12" shot, soft steel weight 850 lbs.	2000 f. s.	Line of fire 21° from normal, projectile went through plate and backing, breaking up into large pieces, hole through plate 12¼" diameter, and fairly smooth, plate badly cracked.
-S. 12" A. P. shell, fitted Johnson cap.	2000 f. s.	Perforated plate and broke up. Through cracks developed.

DATE OF TRIAL.	CHARACTER OF PLATE.	PREVIOUS IMPACTS.
1897 Jan. 8.....	Carnegie, nickel steel. Harveyized, reforged. 22′ 8′ x 8′ x 6″ flat. Unbacked.	(1.) Carpenter 6″ A. P. shell at 2122 f. s., went through plate up into small pieces. (2.) Carpenter 6″ A. P. shell at 2050 f. s., broke up, all pieces large piece of base going through plate. (3.) Carpenter 6″ A. P. shell at 1957 f. s., smashed on plate, he into impact, no cracks in plate. (5.) Carpenter 6″ A. P. shell, fitted with *thin* hollow cylindric cap, filled with graphite lubricant, striking vel. 1986 f. s., brok remaining sticking in plate.
Jan. 20.....	Carnegie, nickel steel, Harveyized, reforged. Same plate as fired at Jan. 8th, 1897. 6″ thick. Unbacked.	(6.) Wheeler-Sterling 6″ A. P. shell, diagonal, smeared with lu 1986 f. s., broke up, head remaining sticking in plate. (7.) Carpenter service 6″ A. P. shell, cavity filled by steel plu ting a solid shot, at 1986 f. s., smashed on plate. (8.) Carpenter 6″ A. P. shell, fitted with cap similar to that use 5, except that the walls of cap were ¼″ thick instead of $\frac{1}{18}$′ vel. 1957, broke up, 25 pieces recovered, all going through plat (9.) Carpenter 6″ A. P. shell, fitted with cap precisely similar to in round 8, striking velocity 1825 f. s., smashed on plate, penetra (11.) Carpenter 6″ A. P. with hollow cylindrical copper cap filled with graphite lubricant, striking velocity 1796 f. s., p plate, making smooth hole, and broke up, all parts going thro (12.) Carpenter 6″ A. P., fitted precisely as in round 11, strikin 1821 f. s., perforated plate and broke up into large numbers Fractures seemed to indicate an inferior projectile. (13.) Carpenter 6″ A. P. without cap, at 1859 f. s., smashed, hea in plate. (16.) Carpenter 6″ A. P., fitted with solid copper cap, coating o between projectile and cap, striking vel. 1807 f. s., smashed disintegrating in an unusual way. Fractures indicate a pro very poor quality. (17.) Carpenter 6″ A. P., fitted with hollow steel cylindrical cap and 3¼″ inches high, at 1784 f. s., perforated plate, breaking dently a good quality of shell.

PROJECTILE.	STRIKING VELOCITY.	RESULT.
ter 6″ A. P. shell, fitted Johnson soft steel cap, ht 100 lbs.	1986 f. s.	Projectile went through plate, making a smooth hole 6″ in diameter, and was found in butt broken into large pieces.
arpenter 6″ A. P. shell, with Johnson soft steel weight 100 lbs.	1825 f. s.	Projectile went through plate, making a smooth hole 6″ in diameter, and was found in butt broken into large pieces.
arpenter 6″ A. P. shell, with Johnson soft steel but without lubricant.	1813 f. s.	Projectile smashed on plate, head remaining in hole, penetration about 6″
arpenter 6″ A. P. shell, with Johnson soft steel but without lubricant.	1821 f. s.	Projectile broke up, about half going through plate, hole rough and 7″ in diameter.
arpenter 6″ A. P. shell, with Johnson cap.	1785 f. s.	Perforated plate and broke up, 30 pieces recovered, largest weighing 23 lbs., and the whole 70 lbs. Projectile was of excellent quality.
arpenter 6″ A. P. shell, with Johnson cap.	1793 f. s.	Perforated plate and broke up, four pieces recovered weighing 91 lbs., of which the largest weighed 63 lbs. Projectile was of excellent quality.

NOTE.—This plate appears to have been one of unusually good quality from the severity of the tests to which it was subjected, cracking and breaking as it did only when the impacts formed a network of holes close together. It appears, however, to have been somewhat weakened by the great number of impacts, as the later rounds seem to show.

Results of Recent Experiments with Krupp Face-Hardened Armor.

Impact.	Gun. Cal.	Projectile.	Weight. lbs.	Striking Velocity (f. s.)			Energy. ft. tons.	Effect on Projectile.	Effect on Plate.
				Actual.	From Formula.	By "Krupp" Formula.			
				Krupp, 5″ .75. Hardened nickel steel. Plate No. 41311. December, 1894.					
5	8″ .3	Krupp	209.4	1643.4	1637	1719	3920.8	Broke up, one part found in front of plate, point and remaining fragments lodged in backing.	Previously attacked by three 5″ .9 projectiles and one 8″ .3 projectile, none penetrated, 3 surface cracks.
				Krupp, 5″ .75 hardened nickel steel. Plate No. 425 B. December, 1894. Previously attacked by two 5″ .9 Krupp A. P. projectiles. No penetration or cracks.					
3	8″ .3	Krupp	211.	1561.7	1630	1712		Broke up.	Plate not perforated.
4	8″ .3	"	210.5	1627.	1630	1712	3862.	Broke up, number of pieces through.	Plate stamped through.
5	5″ .9	"	112.4	2021.	1884	1981		Broke up, pieces lodged in backing.	Plate stamped through, part of back bulge broken out.
				Krupp, 10c/m (3″ .9), face-hardened nickel steel. Plate No. 475. Previously received 6 impacts with 4″ .1 and 5″ .9 projectiles. March, 1895.					
7	5″ .9	Krupp	112.4	1341.9	1407	1342	1403.1	Broke up, fragments of projectile in shot hole weighing 100.3 lbs.	Perforated, section punched out.
				It is interesting to note that a 5″ .9 Krupp common shell with bursting charge of 25.4 lbs. was fired at this plate at a velocity of 2107.7 f. s.; the shell exploded, the plate was perforated and a section broken out, fragments of punched out section passed into backing, and back of plate broken out to a diameter of 30″.				
8	4″ .1	Krupp	35.3	2067.3	2094	1996	2094.	Broke up into small fragments.	Section punched out.
				Krupp 3″ .1 face-hardened nickel steel. Plate No. 476 A. October, 1895. Backed. Previously attacked by 2-3″ .5 and 2-4″ projectiles, no penetration, slight surface cracks.					
5	5″ .9	Krupp	88.2	1333.7	1276	1207	1087.2	Broke up, fragments perforating plate and passing through backing.	Perforated plate and backing, section of surface of plate about point of impact driven into backing.
6	4″ .1	"	35.3	1775.3	1762	1586	842.6	Broke up, fragments in front and rear of plate.	Projectile perforated plate and punched out section, which was driven into backing.

Previously attacked by 3 3″ .5 shells—not perforated or cracked.

4	4″ .1	Krupp	35.3	1376.	1762	1586	463.4	Broke up, point got through, remainder rebounded.	Perforated, punched out section which passed into backing.

This shell is believed to be of extraordinary quality, and at the same time the plate appeared to be inferior to No. 475 A which resisted the attack of two 4″ .1 shells fired with velocities 1412.1 and 1522.7 respectively.

Krupp, 350$^{m}/_{m}$ (13″ .78) hardened nickel steel. Plate No. 575 A.
Tested at Meppen, August, 1896. Backed with 60$^{m}/_{m}$ oak.

1	12″	St. Chamond	717.29	2116.5	2048	2676	22269.5	Broke up, 2 large fragments found in front of plate.	Hair cracked, ogival penetrated plate and pushed out section which lodged in backing.
2	12″	St. Chamond	718.6	2119.8	2047	2674	22376.0	Sticking in plate, body split lengthwise.	Back bulge opened to a width of 80$^{m}/_{m}$, hair cracks.
3	12″	St. Chamond	715.6	2103.6	2050	2679	21940.4	Broke up, ogival welded in section, punched out, fragments found in front of plate.	Section pushed out and lodged in backing, further hair cracks developed.

Krupp, 368$^{m}/_{m}$ (14″.49) hardened nickel steel plate. No. 619.
Meppen, August 28th, 1896.

1	12″	St. Chamond	715.6	2159.	2127	2818	23115.	Broke up, mushroom welded into section of plate punched out, fragments found in front of plate.	Projectile punched out section, surface cracks developed.
2	12″	St. Chamond	715.7	2157.	2127	2818	23086.	Broke up, mushroom welded into section of plate punched out, fragments found in front of plate.	Projectile punched out section, surface cracks developed.
3		Krupp	718.1	2152.	2125	2815		Broke up, head stuck in plate.	Section of plate pushed out, fine cracks.

Krupp 300$^{m}/_{m}$ (11″ .8) hardened nickel steel plate.
September 15, 1895.

2	12″	Krupp.	715.4	1889.	1825	2321	17690.	Broke up; head sticking in plate, fell off at next round. Penetration 7″.	No cracks.
3	12″	"	712 6	1993.	1829	2326	19614.	Broke up head.	Three surface cracks developed, the greatest depth being 3″ .5. Back bulge, 3″ high, containing small crack 5″ .9 in length.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MILITARY TRAINING.*

By HENRY G. BEYER, Surgeon, U. S. Navy.

GENTLEMEN:—The training of the soldier, though in actual practice not a part of the duty of the medical officer, must nevertheless be considered a problem in practical physiology and hygiene, and as such it justly excites both our interest and sympathy.

The same training exactly that applies to the soldier may, with but little modification, be applied to the man-of-war's man, for, say what we will, since masts and sails on board a man-of-war have been altogether displaced by engines and steam, since the sailor can no longer go over the masthead for his morning and evening constitutional, and work on the sails, he has become more of a soldier than he was, and consequently needs more of a soldier's training than he did in former times.

By military training, therefore, I would have you understand not only the application of certain gymnastic exercises, intended to develop the physique of the soldier in certain spots, but the term, as here used, implies a study of the influence which a soldier's occupation, with all its many accompaniments, has on the man as well.

From such a study we will find that the ideal, properly brought up and finished soldier is an athlete in the modern sense, and one who has no superior in the field or out of it.

We will, I hope, come to the further conclusion that the soldier has not only but little to learn from a sport like foot-ball, but that unless, indeed, every man in the ranks as well as every officer

* Written for the Association of Military Surgeons of the United States.

be taught to play it, it would even prove a direct disadvantage when considered seriously.

The most senseless statements have been made in the most rambling sort of fashion as regards the wonderful influence of foot-ball and other athletic sports on the soldier, as if it was the universal panacea and *sine quâ non* for all military purposes. I am, on the contrary, of the opinion that the soldier *per se* has nothing whatever to learn from, for instance, foot-ball discipline, but should rather say, if there must be discipline in foot-ball training, it simply is military discipline applied to an athletic sport, and whoever advocates foot-ball training as being an aid to *military* discipline puts the cart before the horse, and can have very little idea of what discipline really is and where it originated.

As regards the amount and kind of strength and endurance to be derived from foot-ball training, though very great and most satisfactory for a sportsman, these do not come up to the amount and kind of strength and endurance now-a-days required of the finished soldier.

If we could ascertain and express in foot-pounds the amount of work done in a given time by the soldier in the field during, say, an autumn-maneuver, as easily as we can count the number of bacteria in a given quantity of water, and compare this to the amount of work done by any other athlete or strong man for the same length of time, we would find the soldier far ahead and in better condition at the end of it than is either the sportsman, athlete or strong man.

Foot-ball is, after all, mere play, and should never be regarded as anything else. A soldier's calling is and must be of a more serious nature, having a more serious object, and kindergarten methods do not apply to such training, at such an age and for such a purpose. It is merely a fine pastime and recreation.

My ideal soldier would be the one whom we find represented by the infantryman of the best European armies, and the conditions and requirements peculiar to and unavoidable in the United States, when compared to those of Europe, no matter how different they may be, can have no essential modifying influence upon our conception of what the soldier ought to be and what our aim should be with regard to his training.

In writing this paper, and before proceeding with the subject

with which I have been charged by your literary committee, I must acknowledge my indebtedness to Dr. Leitenstorfer, to whose valuable monograph* I owe much of what I have to say on Military Training in the pages that follow.

One of the fundamental conditions for the successful training of the soldier being the harmonious co-operation of the training officer and the military surgeon, we must begin by studying the nature of this bond which so closely unites both their interest and responsibility in this work.

The human body has been spoken of as a workshop in which every organ and cell performs its special duty assigned to it, in its proper time and place, and for the common good of the whole.

But work, in the mechanical sense, is done by muscle and muscular organs alone. Since all training, as applied to the human subject, has for its object and purpose the increase of man's capacity for work, it is with muscle more especially that the physical trainer has to deal. A knowledge, on the part of the trainer, of the physiology of muscle must, therefore, be considered the *conditio sine quâ non* of all successful training.

Let us, therefore, briefly review the most essential points in the physiology of muscle and of those other organs and tissues upon the functions of which muscular work most directly depends.

Muscle.—By far the most distinctive and important property possessed by muscle is its *contractility.* All the tissues, even bone, possess a certain amount of elasticity, but muscle alone is *contractile.* The biceps muscle, in contracting or shortening, flexes the forearm upon the arm. In so doing that muscle performs a certain definite and measurable quantity of work. When a long muscle is made to contract as much as it can, it loses about half its length, but gains in circumference and hardness what it has lost in length. A muscle never contracts without a stimulus. Of the various stimuli to which muscle answers by a contraction, the only one that can interest us here is the stimulus transmitted to the muscle through its motor-nerve and coming directly from the brain.

Voluntary or skeletal muscles are under the direct control of our will, and can be made to contract, therefore, by an effort

* Das Militärische Training, etc., von Dr. Leitenstorfer, Oberstabsarzt 1. Klasse u. Regimentsarzt im K. B. Infanterie-Regiment König Wilhelm von Würtemberg. Stuttgart, 1897.

of that will as much and as often as we desire, while *in*voluntary muscles, not being under the control of the will, contract in spite of our will.

The trainer, therefore, addresses his efforts to the voluntary or skeletal group of muscles only, or those that are attached to and move the skeleton.

As soon as the stimulus conveyed to the muscle from the brain ceases, the contracted muscle returns to its normal resting length. In case it is desirable to keep a muscle in a state of contraction for some time, a series of very quick impulses becomes necessary. Stimuli are then sent into the muscle in quick succession, but none is as strong as the first, and by-and-by they become weaker until they cease entirely.

The trembling which we notice about the entire limb during this tonic contraction of its muscles is simply due to the various stimuli running in quick succession through the nerves into the muscles attached to it, and does not necessarily mean the fatigue of the limb.

Muscle possesses a certain property known as tonus or tension. This tonus denotes a condition of constant readiness for making a contraction. The tonus of a muscle is not yet work, but is rather a preparatory stage of it, and passes into actual work imperceptibly.

Co-ordination is the harmonious working together of all or certain groups of muscles, while muscle-sense is that property of muscle which has been acquired by experience and developed by practice, and by means of which the muscle estimates, as it were, the amount of pressure of any weight or resistance that rests upon it; this sense is more particularly developed in balancing exercises. Persons with locomotor ataxia have no muscle-sense, and consequently are unable to balance themselves with their eyes shut.

The chemical process which accompanies muscular contraction consists in the oxidation of certain definite quantities of carbo-hydrates and fats into carbon-dioxide, accompanied by the production of heat. Under ordinary circumstances the muscular substance remains intact and only loses part of what it had stored up in fats and carbo-hydrates, and which it had taken from the blood during its resting stage. "*The muscle cannot nourish itself during contraction.*" If we were capable of replacing these

substances as fast as they are used up, no fatigue would be possible, since, however such substances can only be appropriated by the muscle during the periods of rest, they are exhaustible through continued work.

It is the same with the products of wear and waste; these also require a condition of rest to be thoroughly removed, and their presence alone in the muscle would be sufficient to put a stop to its work.

The circulation of the blood is charged with the two-fold office of supplying new material, as well as with that of removing the old and used-up substances. Hence the increased circulation in every working muscle and the reflex dilatation of its blood-vessels. For the reason that, in a strongly contracted muscle, the blood-flow through it is impeded on account of its blood-vessels being compressed, it follows that a continuous contraction is much more quickly fatiguing to a muscle than are contractions alternating with periods of rest, no matter how short. When in a state of fatigue the muscle possesses less tone and elasticity, and is therefore much more easily overstretched than normally. This condition is particularly to be dreaded on account of its serious and, most likely, permanent consequences when affecting the muscular substance of the heart.

For the reason that muscle can be nourished only during rest, the oftener a muscle is fatigued by work and allowed to rest for the sake of recuperation, the more often also recur these periods of nourishment, and muscle grows in consequence. Overdoing, however, produces swelling, heat, pain, inability to contract, and delay in normal recovery, on account of the normal conditions being seriously interfered with. As the muscle grows in extent, its capacity for storing up energy also becomes enlarged. Hypertrophy of muscle can only be applied to that condition in which the normal bilateral symmetry is destroyed—by one side of the body showing much more muscular development that the other. This condition may prove a source of weakness rather than of strength, and should, therefore, be guarded against. A steady and uniform increase in the size and strength of all the muscles at the expense of useless fatty tissue is the ideal which we wish to attain.

Lungs.—It cannot be doubted that, of all the organs that are concerned in training, outside of muscle itself, by far the greatest

and heaviest requirements are put on heart and lungs. It is these two organs, therefore, that also require to be watched with the greatest care in individual cases, since no previous physical examination can be considered an absolute guarantee in all cases that they will stand the pressure of training. Extreme pallor, with an abnormal pulse during muscular efforts, should meet with early and careful attention.

When we consider that the function of the lung consists on the one hand in removing carbon-dioxide from the blood, and on the other in supplying oxygen to it, it ought to be perfectly clear that breathing must become more rapid in mounting a flight of stairs than it is while lying down. The explanation is a, comparatively speaking, simple one: The muscles of the legs have performed a large amount of work in raising the weight of the body to a height of from 15 to 25 feet in a short space of time. In overcoming so large an amount of resistance the muscles concerned in the task had to use up a certain quantity of fats and carbohydrates producing carbon-dioxide, and needing for this purpose an increased amount of oxygen. This increased exchange of oxygen for carbon-dioxide must be effected through the lungs, and hence their greater activity during exercise.

The retention of carbon-dioxide in the blood would result in the quick suffocation of the muscle and end its work.

In a person, while at rest, the number of respirations is sixteen in a minute; during sleep it may be still less; during work it may be from twenty to thirty; under hard work, as mountain-climbing, running, dancing, it may be increased to forty to sixty per minute; while during racing it may be increased to the extraordinary number of 100 to 140. But such frequency in the number of respirations would indicate respiratory insufficiency; frequency increased at the expense of thoroughness.

The following table, taken from Leitenstorfer, shows the approximate amounts of CO_2 exhaled:

	CO_2 P. M.	No. Resp.	Pulse.
Sleeping	0.38	10–12	60–70
Lying down	0.57	16	75
Walking	1.42	20	80
Walking fast	2.03	26	100
Climbing	3.38	30–60	120–160
Maximal Work	....	100–140	200–240

While, in climbing, the amount of CO_2 exhaled is ten times that while sleeping, we ought also to breathe ten times more rapidly than we do while sleeping, which would make $10 \times 12 = 120$ times.

But breathing while sleeping is very superficial, which is, of course, not the case during a steep climb, when our whole lung area is engaged in the exchange of gases. We experience, as the effects of training, especially of running, an enlargement of our lung capacity, which normally varies from three to six liters.

Heart.—The relation of the heart to muscular work is similar to that which the lung has; it also must answer to an increased demand for work by more numerous and more voluminous contractions than it makes during rest, for much more blood flows through the muscles in a given time. To this must be added the increased resistance which the contracted muscles oppose to the flow of blood through them, resulting in an increased general blood-pressure, which the heart must sustain. The greater the muscles and the larger their number engaged, the greater also must be the resistance opposed to the blood-flow, and the greater, consequently, the increase in blood-pressure to be overcome.

While respiration is aided by the muscles of respiration which are skeletal muscles, and under the control of the will, the muscular action of the heart is perfectly independent of our will. In the main, however, both the heart and the lungs in their action are governed primarily by the want and the necessity for the exchange of gases in the blood. Want of oxygen and over-accumulation of carbon-dioxide in the blood and the tissues generally stimulate the automatic nerve-centres of the heart to greater activity, and the number of contractions may thereby be enormously increased, until, in some cases, the heart-beats are three times their normal number.

Just as was the case with the lungs, abnormal rapidity of contractions on the part of the heart must sacrifice the thoroughness of its work. When the heart beats at the rate of 160 times per minute, the ventricles contract before they are half full with blood; the pulse, though rapid, is small and feeble, for the arteries are incompletely distended. The contractions of the heart itself are incomplete, being inadequate to the demands put upon it, and consequently we have as a result a momentary insufficiency of the heart, which, however, given a certain period of rest, returns

to the normal, providing the heart was originally sound and not altogether unprepared for an occasional demand upon the endurance of its muscular tissue for an extra amount of work.

A muscle, the functional activity of which, as in the case of the heart, is so intimately related to the action of all the other muscles of the body, also shares in the main the fate of the latter. It is exercised and strengthened the same as, if not more than, the other muscles by carefully systematized work, and becomes soft and degenerates through lack of exercise the same as they do. A certain amount of hypertrophy of the heart, as long as this is in proportion to the increased growth of the rest of the muscles, is not a disadvantage, but rather an expected and quite necessary gain. While no two hearts are exactly alike, the greatest possible difference is found between the heart of an athlete and that of an office clerk, yet both may be normal in their relations to the whole body. A strong heart is one of the essential conditions which determines beforehand the amount of work which a man is capable of performing. General weakness of the heart-muscle, distinct lesions or valvular troubles limit the amount of work a man is capable of doing from the beginning. The muscles of the heart must be trained through graded, systematic efforts just the same as other muscles, if a higher degree of working efficiency is expected. Since, however, the two cannot very well be trained separately, no special gymnastics for the heart are necessary, at least not under normal conditions, with which alone we are here concerned.

An untrained and unprepared cardiac muscle must surely give out on sudden demand being made on it for an unusual amount of work, and permanent injury is liable to be the result. Any muscle, in a state of fatigue, can easily be stretched beyond its normal resting limit and thereby loses much of its tone and elasticity.

It must, of course, be quite apparent that the muscles of the heart, when weakened by hunger, starvation or fever, must become prematurely fatigued, consequently this organ is much more liable to be over-distended in this condition when an unusually large quantity of blood is poured into its cavities, as is done during hard work. An over-distended heart will not admit of perfect closure of its valves, and to the inefficiency of the heart-muscle there is added the insufficiency of its valves. This sort

of inefficiency is, as a rule, very serious, and leaves permanent after effects which forever after disable a person from exerting his utmost powers without producing heart failure. Cases of rupture of the heart and of its valves have been observed everywhere, especially in connection with athletics. In a post-mortem which I had the opportunity of making on a young cadet aged 18 years, who was a very determined and enthusiastic high and broad jumper, a pole vaulter and hurdle jumper, the aortic valves were all gone, except a few narrow thickened shreds near the ring, where they were attached; the mitral valves also had nearly disappeared; this was the result of going into competition without previous training for the event.

Over-distension of the muscular walls of the heart with all its disastrous consequences may also be produced by heavy lifting. Heavy lifting results, as a rule, in over-distension of the right ventricle on account of the action of the lungs being suspended and their capillaries being compressed, thus preventing the flow of blood through them and thus from the right to the left side of the heart, consequently the right side must be distended with blood. The same condition exists during forced diving and for the same reasons.

There are certain conditions of the heart that would exclude its owner right from the start from any course of training whatsoever. If, for instance, it should be found that a slight amount of exercise would cause the heart to beat out of all proportion to such exercise, the chances are that, in spite of the appearances of perfect symmetry and health, there exists some malproportion as regards the size of the heart when compared to the blood-vessels to be supplied. At last there is the irritable heart, which reacts abnormally not only upon exercise, but also upon psychical emotions. All such cases are to be excluded from both the military and naval services.

Motor Nerves.—The seat of the will, in obedience to which all voluntary muscles may be caused to contract, is in the gray matter of the brain. From the cells composing this gray matter fibers originate and travel through the brain and spinal cord into peripheral nerve-cords, and finally terminate in muscular fiber. An act of the will, whatever that may be, means a certain amount of work done by these brain cells and, therefore, presupposes the loss of a corresponding amount of stored-up

energy in the brain; increased combustion and metamorphosis accompany brain work, just the same as they do muscular work. The nerve-fibers, simply conducting the various impulses from the brain to the muscles, seem to play a merely passive rôle in the process.

The strength of the ensuing muscular contraction is directly dependent upon the strength of the stimulus generated in brain-cells. It does but *seem* as if the muscle of its own accord produced the required strength for its contraction to overcome resistance. Sometimes we rather underestimate the amount of stimulus required for lifting a certain weight. The first contraction of the muscles is, then, not equal to the task and now a stronger stimulus is sent to the muscles and so on until the contraction produced is equal to the resistance to be overcome. An act of the will producing muscular contraction, in other words, a motor-impulse, is a product of work done by brain-cells and directly determines the strength of the muscular contraction that follows. The greater and the more intense the process of combustion going on in brain-cells is and the longer in duration, the stronger and longer also will be the muscular contractions that follow it. Both the energy stored up in muscle, as well as that stored up in brain-cells, is supplied from the blood; the blood also removes the products of wear and waste in rushing through these tissues. Inasmuch as it takes time to restore the lost nerve-energy, it is not difficult to imagine certain conditions and circumstances which would tend to completely exhaust it, and then muscular work would cease purely and simply on account of the absence of motor-impulses. Thus we see that fatigue of the brain and spinal cord may occur quite independently from fatigue of the muscles.

We know that during muscular contraction the blood-vessels in the muscle become dilated, and thus more blood flows through them than during a state of rest. The same increased circulation is met with in the brain during its activity. Energy is used up very rapidly and the waste-products are quickly removed. Like muscle, the brain cannot appropriate new materials from the blood to take the place of those that had been expended during a state of activity. Now, while a fatigued muscle will recover after a certain amount of *rest*, a fatigued brain needs *sleep* for its recovery. The increased blood-flow through the brain,

when in a state of intense activity, as well as through the muscle during its work, is chiefly intended to aid in the processes of combustion by furnishing the necessary oxygen and in removing the products of such combustion, but repair of brain energy can only take place during a state of rest, just the same as we have found to be the case with muscle energy. "During sleep we find the brain plentifully supplied with rich arterial blood; the better this supply the profounder also will be the sleep, and the more thorough, consequently, will be the repair of the lost energy." (L.) "Indeed, the drowsiness temporarily produced by over-indulgence in alcoholic liquors, finds its explanation in the arterial congestion of the brain which it produces." (L.) Overwork, forced marches, hard mountain-climbing produce the contrary conditions. The overworked muscles, with their dilated blood-vessels, require and hold within their meshes a greater quantity of blood than usual, and the likewise fatigued brain consequently cannot get its proper share, and for this reason sleep is either impossible or superficial or comes on later, that is, after the muscles have already returned to their normal condition and we wake up feeling perfectly rested so far as our muscles are concerned, but such sleep has not proved as refreshing as normal sleep usually does. In fact, the influence of a sleepless night upon our feelings is well within the experience of every one of us, and would go far in showing the great importance and necessity for a thorough and complete restoration of our lost energies and the direct dependence of their restoration on sound sleep.

If this condition recurs frequently, or if other conditions are combined to still more disturb and impair the normal process of nutrition of the brain substance, maximal muscular contractions and feats of endurance become absolutely impossible; forced marches are things of the past, and a condition, known as neurasthenia, the natural result. Neurasthenia, then, is the direct consequence of a disturbance of the proper balance to be maintained between supply of nutriment to the brain and demand of work done by its cells. The organ which produces the will has lost its very source of strength. The motor or voluntary impulses which are able to force into activity even fatigued muscles are themselves devoid of those substances upon the presence of which depend their auto-productive and creative energies. The condition known as endurance depends not so much on muscular

power as it does upon a strong will, and this again finds its *fons et origo* in a well-nourished brain. A lack of endurance also constitutes one of the cardinal symptoms of all neurasthenics. Among the more general causes which are productive of neurasthenia, besides actual hunger and a starvation diet, the principal ones are alcoholic and sexual excesses. These may be the causes that destroy the endurance needed just at the most decisive moment; through over-indulgence in such excesses, the benefits of a long process of careful training may be lost in a single night. If this happens among a number of soldiers just proceeding on an arduous campaign, these will be found unequal to their comrades, and the dangers of hot, forced marches will make as heavy inroads among them as they do among those entirely untrained and unprepared. It is not muscular strength that was lost in such a short time, but it is nervous energy or brain energy—the motor power has been destroyed and wasted. The muscles become prematurely exhausted, the heart muscles included, because that which gives them their endurance has been taken away. It is for this reason that athletes, while preparing for a decisive game or race, in both of which success depends upon every man's doing his duty to the very best of his ability, give their word of honor not to use either alcohol or tobacco nor indulge in sexual excesses during the period of training.

The training of a whole army corps is, however, not as easily protected against dangers such as these, and since a few may, nevertheless, endanger the success of a large body of troops, since the rapidity of their united advance is not that of the favored few, but that of the slowest among them, means to that end must be taken and attempts at corruption from that quarter guarded against with special vigilance.

As has already been mentioned, besides want of sleep, alcoholic and sexual excesses, hunger, of course, is the most direct cause of a want of nerve energy and endurance.

Any cause preventing the proper and timely supply of those substances in which our energies are stored up after they have been exhausted, must tend to make further work impossible without the very structure and vitality of the organs themselves becoming seriously attacked. At first this attack will be felt in those organs that are directly engaged in the work, but after-

wards the entire organism will be drawn upon and a general loss in weight will be the result.

To what extent and how profoundly hunger influences the activity of the brain may be seen in the expressions of impatience and irritability with regard to more or less all things shown by some people before meals, as compared to the more benevolent placidity which characterizes the same individuals after they have had their meals. This feature undoubtedly shows part of the animal nature of man. We know that every wild animal is particularly wild when attacked or in danger on an empty stomach, and it may be considered good and sound advice, if one man has an important favor to ask of another, that such request had better be made of him after meals than before, even under ordinary circumstances of life.

While this condition of temporary neurasthenia is quickly gotten over, continued starvation finally leads to real neurasthenia which is of longer duration. The will power is gone simply because the fuel has been used up. In this respect the human body may safely be compared to a machine that is insufficiently supplied with fuel, and, consequently, stops. Every well-informed husbandman knows from experience that the amount of work to be gotten out of his farm hands depends, among other things, largely on the quality and quantity of the food which they are supplied with, and every commander of troops should know and realize that the success of those troops, the endurance of long and fatiguing marches, the rapidity of his advance, will be in direct proportion to the quantity and quality of the rations that are supplied to his men.

Those of us who have had opportunities of watching men in training for either foot-ball or a boat-race know from experience that there comes a time when a few of their number begin to complain of lack of sleep at night, of drowsiness and general apathy during the day, and a general lack of endurance, both mental and physical. This is the condition known as "over-training" and the result of a disturbance of the normal balance between supply and demand. It may be that the normal limits of their capacity for training have been reached, if not surpassed, or the condition may also have been produced from lack of sleep, insufficient food, an intercurrent attack of indigestion, etc. In many cases it is due to neither of these causes, but rather

an indication that the maximum limit of the weight and strength capacity of the particular number of individuals concerned has been reached and their condition simply stands as the outward expression of this fact. Their nervous and muscular organizations refuse being developed to any higher degree of functional ability or efficiency. It is well known that there exists a natural limit in both directions for every individual, and every attempt to develop him beyond that limit leads and must lead to neurasthenia. This natural limit differs with every individual; it also differs at different periods of life for the same individual. As a general rule, it may be said that after middle life the normal period of repair of used-up energy begins to be lengthened or takes a longer time for its accomplishment, and, on the other hand, the energy itself, both muscular and nervous, is more quickly expended and used up than was the case during previous years, and consequently neurasthenia becomes more frequent in later life. The important bearing which these facts must have on training is self-evident. Consider for a moment the variegated composition of our army, navy and militia, as to the ages represented by the different men, not talking of the difference in their nationality. In the armies and navies of Europe we find that the age limit of the rank and file is limited to from 20-23 years, and forms a tolerably uniform factor in the problem. Much greater care and circumspection are necessary in the training of such a composite body of men as compose our military establishments than in Europe. Individualization is much more often called into requisition in the United States army than in the armies of Europe; a classification according to age previous to a course of training is almost as necessary as the required physical examination before enlistment.

It is a fact, admitted and accepted by the most experienced trainers, that a period of six weeks of training, provided such training has been graded and systematic, will result in developing the men to the utmost limits of their capacity. Every attempt to maintain this maximum condition of training for a longer period has invariably failed. Instead of obtaining a further increase in weight and endurance after the period of six weeks, the very contrary occurs, namely, loss of weight and especially loss of endurance, showing the nervous factor in the equation. In other words, after the period of six weeks we must expect the condi-

tion of overtraining to become general, if not a short period of rest follows the training.

Whenever the state of overtraining comes on prematurely in certain individuals, it may generally be known by the particular individuals not having gained the usual and customary amount of weight during the training period so far as it has advanced. It has been found in the beginning of training, generally during the first week, that a slight loss in weight occurs. This loss is followed, normally, by a steady and continued gain until the fourth week, from which time on the weight becomes steady and the maximum strength capacity of the individual is reached. Many a game of foot-ball, many a boat-race, has been lost owing to the fact that the team or crew was overtrained and *not* because their work was inferior; it is one of the most difficult tasks to convince an enthusiastic trainer that his men are in a condition of overtraining and need rest. Mere argument and advice will rarely suffice, and unless the medical officer has the necessary authority to enforce his suggestions, the resulting disaster becomes inevitable and may be foretold. Dr. Leitenstorfer speaks of having seen whole bataillons in this condition of overtraining. Those who show earlier symptoms of overtraining do not possess the capacity necessary for the event, whatever that may be, and should be promptly excluded if their health is to be respected and the success of the remainder to be assured. The usual and most common signs of neurasthenia are well known in the overtrained and are easily recognized: their character seems entirely changed, they have become extremely irritable and explosive in their expressions and demeanor; they are disheartened themselves because they realize their state of health, though unwilling to admit it; they have lost their former endurance and are quickly fatigued; continued training in such cases is not only useless, but generally results in permanent and serious injury.

Now in this condition of overtraining, the anatomical or histological integrity of brain and spinal cord is not necessarily impaired, the trouble being merely functional and temporary. The machine does not work properly on account of inadequate supply of fuel. Still, a still further abuse of these structures through continued and impossible demands on the muscles for work, may also finally lead to real structural changes and cause permanent disease of these organs. It sometimes happens that temporary

paralysis is caused by excessive work of certain groups of muscles, even during the period of training. A case of this kind occurred at the Naval Academy during training for foot-ball, in which one whole arm was paralyzed twice within five weeks. The arm was paralyzed for three days the first time it occurred, but the second time it occurred it remained in this state for two weeks. It is well known that the persistent and more or less systematic abuse of the muscles, especially by professional strong men and athletes, is bound to be followed by disease of the spinal cord. Besides the usual neurasthenic symptoms, the final outcome is the disease known as "progressive spinal muscular atrophy," which is followed by general marasmus and degeneration of the cord.

Leitenstorfer cites the case of a professional strong man who exhibited himself for some time and was able to swing a pair of dumb-bells weighing 120 pounds each, while his body was supported by his head and heels resting on the edges of two chairs. After a period of two years of such exhibitions, progressive spinal muscular atrophy declared itself.

Fatigue.—A study of the physiology of exercise shows clearly that muscular work is dependent on the simultaneous co-operation of at least four different organs or tissues, namely, nervous tissue, heart, lungs and muscle, and that muscular work must come to an end as soon as either one of these four factors gives out. Heart and lungs influence muscular work, of course, but indirectly; breathlessness and palpitation of the heart prove by no means that the working organs proper, muscle and brain, are exhausted or even fatigued, for these are able to continue their work just as soon as heart and lungs have recovered. Fatigue proper we call that condition of things in which muscle and nerve tissue cease to function normally. A very concise separation of muscular and nervous fatigue is not always easy, and often impossible. It is nevertheless interesting to know which of the two gives out the quickest in certain exercises, the muscle or the nerve, the will or the flesh, and the exhaustion of which of these two is the most essential.

It is a physiological fact that no electrical current, no matter how strong it may be, is able to produce so powerful a contraction of a muscle as is the motor impulse generated in the brain and conveyed to the muscle through the agency of its motor

nerve. It is, furthermore, well known that after these voluntary impulses for a muscle have ceased to prove effective, the same muscle may still be caused to give strong contractions by the application to it of electrical stimulation. It is clear, therefore, that the muscle was not exhausted, but was still in possession of a certain amount of energy available for producing work; the muscle would have continued to contract had the nervous impulse been strong enough to effect such contraction.

We see, then, that at least one of the causes of muscular fatigue seems to lie deeper and far beyond the mere muscular organ apparently concerned; its own strength is of no avail when the impulses it receives from the brain are not sufficiently strong to excite it to action. No doubt, muscle can be fatigued, but its fatigue occurs long after fatigue has become manifest in nerve tissue. It is the brain that limits muscular work, and fatigue finds its last cause in the exhaustion of those of the cells of the cortex from which motor impulses originate and are sent out. Some of us also may have witnessed the feats of strength that are done under the influence of an over-excited brain. The dementia and paralysis which follow certain maniacal excitements are examples which show the power and the sway which the brain holds over the muscles. A classification of the different forms of fatigue, although perhaps difficult in some cases, seems nevertheless desirable, and we therefore welcome the attempt made by Leitenstorfer, who makes five different groups of fatigue:

1. Muscle fatigue.
2. Lung fatigue.
3. Heart fatigue.
4. Nerve fatigue or true fatigue.
5. Neurasthenia, or the condition of overtraining, being a more or less abnormal condition and of some duration.

The term exhaustion, according to the same author, ought to apply only to the "highest degree of nerve fatigue affecting the central nervous system and involving the subsequent giving out of all the factors involved in the production of muscular work, including the heart's action." In a medical sense, and according to this definition of exhaustion, it would be "wrong to report a bataillon having arrived completely exhausted, say after storming a height and arriving on top covered with dust and

perspiration and somewhat out of breath"; nor would that term apply to a boat's crew after a long and fatiguing pull against wind and current when, in a very short time, both the battalion and the boat's crew, after some rest and without taking any nourishment, each in turn is able to continue on their respective duties. The condition in which the soldiers arrived was simply one of an acute temporary fatigue of heart and lung; the same is true of the boat's crew. In either, the muscular and nervous factors, though functioning badly, were by no means exhausted to such an extent as to require nourishment and sleep.

In further illustration of the above classification of fatigue, we will quote some of the examples given by Leitenstorfer in his work:

1. *Muscle fatigue.*—"This occurs in its purest form in heavy lifting, knee-bending, pulling up on the horizontal bar, whenever these are continued until the muscles engaged in the work give out entirely. Here the muscles are quickly used up, while pulse and respiration, though increased in number, would still support further muscular work. A short period of rest for the muscles involved removes this form of fatigue. In case such exercise is pushed to extremes, however, the muscles will swell up and become painful and then the sensations of fatigue in the muscles continue for days."

"During the tetanic contractions of muscles, or whenever certain groups of muscles are expected to keep rigid for some time, muscle fatigue comes on so much more rapidly for the reason that, in the contracted muscles, the circulation is for the time being almost entirely interrupted, the blood-vessels being contracted or compressed and carbon dioxide and the other products of wear and waste cannot be washed away nor fresh oxygen be carried to the muscles. This is also well shown in the act of holding a heavy weight out at arm's length and at right angles to the long axis of the body. In spite of the best efforts of the will, the weight held in the hand will sink until the arm is alongside of the body. Will power in this case was not exhausted, for a short period of rest of the arm muscles suffices to enable the same muscles to do the same work over again. The act, often repeated, would, however, finally involve the nerve centers in the brain and spinal cord which, after awhile, must share the fatigue in common with the muscular structures involved in the exercise."

2. *Heart fatigue.*—"Acute cardiac insufficiency puts a stop to muscular work in the case of a sprinter or a dancer, not because the particular group of muscles engaged in the work is exhausted, but because with a superficial pulse of 180-200 p. m., the heart contracting imperfectly and the blood-vessels being incompletely distended, the muscles do not receive a sufficient blood supply, and, consequently, of the necessary oxygen. A short period of rest will also suffice to remove this form of fatigue."

3. *Lung fatigue* "in its purest form is rare and can occur only in a person whose heart is in the best possible state of training, thus permitting the lung alone to put a stop to muscular work. As a more general thing we will find that heart and lung give out together, and this occurs when the trained soldier rapidly storms a height, over rising ground, fully equipped for war, during the hot season of the year. This form of fatigue also will be overcome by a short period of rest."

4. *Nerve fatigue or true fatigue.*—"This form of fatigue is not the result of short maximal muscular efforts, but rather of long continued average work or a large sum of often-repeated maximal muscular exertions, for instance, long marches, mountain-climbing, prolonged gymnastic exercises, heavy labor. The fatigue thus incurred cannot be removed simply by a short period of rest; rest under such circumstances must be supplemented by food and drink and sleep."

"Complete general exhaustion differs only in degree from this form of fatigue. A single day or night is often not sufficient for its removal, especially when sleep is not prompt in coming on and not profound while it lasts. Perhaps several days and nights are necessary to completely overcome the state of general exhaustion, but finally recovery will take place, providing the men were well trained and under otherwise normal conditions and the proper amount of nourishment and rest were secured."

5. *Overtraining*, or "the neurasthenia following fatigue from overwork. This condition is often the result of injudicious training. Inasmuch as it is neurasthenic in character, it belongs to the form known as true fatigue, depending, as it does, upon the exhaustion of certain nerve centers. In its relation to other forms of fatigue which it resembles in some respects, it is of longer duration, though not incurable. This form of fatigue is caused not by short maximal muscular efforts, nor by a large

number of average muscular exertions, nor by work of an exhaustive nature continued for days, but by work that is continued and constantly increased for weeks in succession far beyond the natural limit set by a given amount of nourishment and a given period of rest for recuperation."

6. *Over-exertion* " resembles more nearly an actual injury done to one or more of the organs engaged in doing or assisting in doing certain work. It may be produced by sudden maximal efforts as well as by continued efforts at work. Heavy lifting or forced diving, giving rise, as they do, to an undue overdistension of the cardiac walls, especially of the right side, may produce it at once. Into this category also belong the partial or total paralysis of certain nerves supplying definite groups of muscles. Pain in the joints and along tendons, caused by their swelling from continued marching, is also often due to over-exertion. Raw recruits often experience a painfulness in the joints, tendons, even bones of feet and legs, while in training. While the significance of such an occurrence is not very great, these accidents should be avoided for the reason that they are apt to cause an interruption in the training. Cramps are due to over-exertion of single muscles."

Practical Problems.—Having briefly summed up in the preceding pages the most important points with regard to the physiology of exercise, we are now prepared to approach the more practical problems involved in the training of the soldier.

We can scarcely make the simplest movement without calling into requisition the action of several muscles at the same time. Even in trying to exercise, for example, a single flexor muscle of one of the fingers, we must exercise at least its natural antagonist, the corresponding extensor muscle also. This double influence must be kept in mind, and is peculiar to every muscular exertion. Just as in tacking a ship and hauling on the yards, both braces are held taut, so also have we, in every muscular performance, two kinds of muscles coming into play, namely, those that do the actual work and those that would naturally antagonize their action. This sort of muscular action is well illustrated in all balancing exercises.

It is therefore difficult, if not impossible, to develop one single muscle by a certain exercise; on the contrary, the most insig-

nificant movement involves the concerted action of an entire group. It is also sheer nonsense to try and enumerate the names of all the muscles involved in a certain muscular act, for most every act of any account would require the enumeration of all the muscles of the skeleton, and a perfect rest of all the muscles can be found only in the " horizontal position of the body, with semi-flexed extremities, the body resting on a soft, elastic couch." We will now pass in review of the principal muscles engaged during the more natural movements required of the soldier and man-of-war's man.

1. *Position of attention.*—Standing in due military form is not a position of equilibrium of the bones of the skeleton. The position, on the contrary, is only maintained through the action of the extensor muscles of the back and those of the hip and knee-joints, together with their antagonistic flexors. The action of these muscles is required for the purpose of balancing the body in its upright position, and, consequently, they must perform a certain amount of work to maintain this position. It is of some importance to know that, in standing in this position the knees, though straight, are not necessarily to be pressed back *ad maximum.* In such a position as this the soldier is enabled, by practice, to assume an attitude at least approaching that of equilibrium from his hip joints up. Notwithstanding this, however, even under these circumstances the point of gravity falling somewhat in front of the line connecting the two hip joints, on account of the chest being pressed forward, work is done by the muscles of the back, of the buttocks and those of the back of the thighs and legs, the mere tonus of the muscles would not be sufficient in keeping the man from falling in a forward direction. Sideward motions are controlled by the tone of the muscles alone. In cases of sudden fainting fits, where men are utterly overcome by fatigue, during which all the skeletal muscles are as if suddenly paralyzed, consequently unable to act so as to maintain the skeleton in the upright posture, the body falls forward. This I have seen illustrated in men who underwent punishment and who were obliged to stand on the deck of a ship, keeping their hammocks on their shoulders during an entire watch of four hours; they would fall straight forward, like a rod, in an unconscious state.

In adjusting a fine chemical balance there comes a time when

both scales will be at rest and the tongue in the center and on top of the horizontal bar points straight upwards and is perfectly immovable, so that its tip would produce nothing more than a fine point on a piece of smoked paper held in suspension over it. Leitenstorfer, applying the method of Vierordt, studied the capacity for balancing on the part of a number of soldiers in different positions by suspending a piece of smoked paper over the points of their helmets. In this manner he produced a large number of cephalo-grams very interesting indeed, and showing that such a perfect balance as may be produced with a scale cannot be approached even by the best trained soldier. A study of these cephalo-grams would show above all that the excursions which the swaying of the body produces on the smoked paper are more extensive in the antero-posterior or sagittal directions than in a lateral one, these being in a proportion of 3 to 1; they show, next, that these excursions increase in extent from minute to minute or the longer a soldier is kept in a definite position, and, furthermore, that the excursions are smaller or least extensive in the best trained soldiers. The excursions are smallest in the sitting position, on account of the pendulum being so much shorter; they are larger in standing at "parade rest," still larger in the "position of attention," larger still in the same position with knees well pressed backward, smaller in the position assumed when shooting, on account of the basis of support being larger than in standing, and largest of all in the position of "knees bent," simply because in this position the basis of support is only two-thirds of what it is during standing.

Every soldier has learned from practice that a march of ten or twelve miles does not prove as fatiguing as will a parade of two hours' duration, and the privilege of stepping out after a long parade is welcomed as a great relief.

2. *Position of "parade rest"* or the "position hanchée" of the French, is also fatiguing, but less so on account of the work required of the muscles in maintaining the position than on account of the painful sensations of pressure exerted on hip, knee and ankle joints of the one side. In this position fatigue comes on sooner than in the position of attention, because in the latter the weight is evenly distributed between the two sides of the body, while in the former the weight of the entire body rests on one leg only.

3. *Walking.*—In walking the upper part of the body is slightly inclined forward, and consequently also the point of gravity. In order to prevent the body from falling one leg is swung forward. Since the hip joints stand slightly lower whenever the body is inclined forward, the leg while swinging to the front must be slightly shortened in order to pass over the ground without touching. In the meantime the rear leg is lengthened because the foot is lowered for the purpose of shoving the body forward, whereupon the rear leg is brought forward, swinging by the other like a pendulum and in a slightly flexed condition.

In Germany two kinds of military walking or marching are distinguished. The one implies a well measured, somewhat rigid step, the foot striking the ground sharply and flatly with the entire sole, body and head erect and kept well balanced; in the other the foot is not brought down on the ground with such force nor strikes it flatly. The first form of step is used on parade, and is therefore also sometimes called the "parade step."

The parade step, when practiced slowly and emphasizing, as it were, every detail necessary for its smooth and complete performance from beginning to end, has become one of the most valued means for the development of all the step-muscles, as well as the muscles that balance the spinal column and head.

The reason why this form of step is not used in ordinary distance-marching of a bataillon, but only as a parade step and as a means for developing the entire step-musculature, is because it is too fatiguing on account of all the muscles of the trunk and legs being in a state of rigid contraction during its performance. During long marches, therefore, and in order to spare the soldiers all unnecessary expenditure of energy, the easiest form of step, that which requires the least expenditure of energy for its performance without, however, allowing the body to become crooked, is allowed.

As regards the keeping of the chest well out and the body erect and slightly inclined forward, which is the rule both in the position of attention as well as in walking or marching and running, I was able to produce much better results by explaining to the men that this particular position was insisted upon not alone because it looks well, but for the more important reason that by maintaining this position all the internal organs, such as the heart and lungs, are in the most favorable position for the per-

formance of their respective functions; the lungs, by being free from the least compression, can expand more freely, and the heart, for the same reason, has the fullest play in all its movements, while the stomach and intestines are well supported by a moderately contracted abdominal wall, the contractions of which co-operating well with those of the diaphragm.

There are six groups of muscles that are more especially engaged in marching, and the proper and efficient development of which is of the greatest possible importance to the soldier: (1) The psoas and iliacus, which elevate the thigh; (2) the quadriceps extends the leg upon the thigh, throwing the foot forward, and when the foot is fixed upon the ground it raises the entire body weight by straightening the leg bent at the knee; (3) the various extensors of the foot and toes, situated on the front and outer side of the leg, elevating the foot and guiding it over the ground; (4) the very strong bundle of muscles about the seat which extend the thigh and pull it backward; (5) the muscles situated at the back part of the thigh which bend the leg upon the thigh and enable the foot to take hold of and grasp the ground; (6) the muscles of the calf which elevate the heel of the foot and advance the body forward.

Upon the proper and efficient development of the above six groups of muscles depends the success of the modern infantry soldier, and with him of the entire army. The Field Marshal of Saxony places the whole secret of modern warfare in the legs, and with good reasons, for by far the greatest and most important part of the work required of the soldier consists in marching.

In accordance with the importance of these muscles to the soldier, and in order that they be developed to the highest degree of efficiency, the most thorough and painstaking leg-gymnastic has been evolved and is practiced in the German army. This practice consists chiefly in slowly but thoroughly going through the different movements which together make up the parade step, and some of you may have seen German recruits going through the maneuver while passing some of their parade grounds. In order to realize the full value of this practice as a gymnastic exercise, I should advise you to practice it on yourselves, systematically emphasizing every and all the separate movements of the dismembered step.

Running.—This differs from walking, not only in the in-

creased rapidity and length of the steps taken, but in that the step is converted into a jump. While in walking one foot always touches the ground, in running there occurs a short period during which both feet are off the ground, as in jumping, and the body is thrust forward through the rapid forward extension of the rear leg.

The muscles which are engaged in running are the same as those that are engaged in walking or marching. During running the point of gravity is put much further forward than during walking, and hence the rapidity with which one foot is put in front of the other to keep the body from falling in that direction. Picture to yourselves a soldier loaded down with 50 pounds of equipment taking 170 steps in a minute, each step of the length of one meter, and you will realize in some measure the amount of work his leg muscles are required to perform.

The Germans also distinguish a so-called "jump step" in running. Just as the parade step or rigid step is derived from the ordinary walking step, is a "higher powered" step, just so is the jump step a higher grade of step used in running, of no practical value in itself but of *very great* value as a gymnastic exercise, and presupposing in the performer already a high degree of strength and elasticity. The jump step is in fact the parade step used in running. While in ordinary running the entire sole of the foot is put to the ground, when using the jump step only the two anterior thirds of the sole of the foot are used, both in supporting the weight of the advancing body as well as in thrusting the latter forward. This maneuver puts extraordinary requirements on the muscles thus engaged.

Jumping.—The same six groups of muscles enumerated above that are chiefly concerned in walking and running, are also the principal ones concerned in jumping. In the jump the discharge of the strength resident in these muscles takes place like a sudden explosion. The hip joint, knee joint and ankle joint being acutely flexed, and suddenly extended by the contraction of the extensor muscles, the body is hurled forward and upward. Before clearing the obstacle, the legs are again drawn up by the flexor muscles and held in this position until just before reaching the ground on the other side, when they are extended once more, in which condition they reach the ground, the weight of the body descending upon the lower extremities as if on a spring.

While then a successful *high-jump* depends upon the quick and powerful contraction of the extensor muscles of the lower extremities, it must not be forgotten that the equally sudden and powerful flexion of the thighs upon the abdomen, and the legs upon the thighs, their closest possible approach to the body until the knees almost touch the shoulder and the heels the buttocks, is an important element in its execution. A much higher obstacle is cleared with the same expenditure of force and elevation of body when the legs are well drawn up than when they are not, the difference ranging from ten to fifteen inches. In the standing broad-jump we do not get this advantage, and this is, therefore, a more accurate measure for the power with which the jumper can throw himself from the ground than is the high-jump. In the running high- and broad-jumps, proper co-ordination and an accurate eye as regards the point from which to jump off, to be acquired only by experience, are also quite essential.

Riding.—At first sight, riding on horseback would seem to imply but a very small amount of muscular work on the part of the rider. Indeed, it must be admitted, if there is any benefit derived through horseback riding, when considered as merely an amusement, the horse certainly deserves to get the lion's share of it, and gets it, too. While the horse is doing a more or less large amount of active muscular work according to its charge, its rider, on the other hand, is rather in a blissful state of *being* exercised, and in this way seems to derive by simple contact a certain amount of benefit from the more active exercise which the horse takes, in the same way that a parasitic animal derives the benefit from foods which his host must digest but without himself expending hardly any nerve force and very little muscular force.

It is, however, somewhat different when we come to study horseback riding as an accomplishment of the soldier. The more or less solid connection between rider and horse is formed by the seat of the former and the back or saddle of the latter. The connection may be likened to a ginglymoid joint, in which the thighs of the rider act the part of the lateral ligaments, allowing only a backward and forward movement. While, then, the seat and the inner surfaces of the thighs are closely attached to the body of the horse, the spinal column and legs must, in all the movements, be so balanced that they remain vertically to the point of gravity of the horse, unless other positions become necessary for

the purpose of either aiding or preventing certain movements of the horse. The muscles that are engaged in riding, therefore, are those that keep the head and body erect from the hips up, and this is done by the back and neck extensor muscles, and those that keep the inner surfaces of the thighs in close touch with the sides of the body of the horse, which is done by the adductors and the seat muscles. These muscles, when properly managed, form powerful aids in driving the horse forward. Inasmuch as even those of the muscles, by which the legs are kept in touch with the horse, are controlled by muscles having their origin in the hip or thigh, the musculature concerned in the act of horseback riding may briefly be said to be located in the seat and the thighs.

The soreness and stiffness experienced in the beginning of the exercise also is found to be confined to these regions and the back, especially the lumbar region. The amount of work done by the muscles of the legs is reduced to a minimum, because the movement of the feet in the stirrups is, comparatively speaking, slight, and consists only in an up-and-down motion requiring but little force. This may be seen in professional riders, in whom there exists a disproportionate development between thighs and legs, as may be ascertained by measurements. This disproportion also is soon developed in cavalry recruits.

A good horseman, in fact, depends not so much upon the amount of strength of his muscles as he does upon the development in his seat and thighs of a certain muscle sense or "horse sense," by means of which he feels the movements which his horse makes or is about to make, so as to enable him to give timely aid to his horse in favorable movements or prevent any that are not favorable to the accomplishment of his own purposes. Good horsemanship, indeed, consists in this very co-ordination, acquired either by experience or inheritance, this working together between horse and rider for a common purpose and to the desired end.

Horseback riding, even for the most accomplished rider, means the performance by the rider of a definite amount of muscular work, and must, consequently, in the end lead to a corresponding degree or form of fatigue. Aside from the consequences resulting from the active work of the muscles directly engaged in balancing, etc., those of the muscles and internal

organs that receive a merely passive form of exercise, a shaking up and jolting, will in time give rise to an increase in temperature and to an increase in the frequency of the heart's beats and the number of respirations. Still, riding alone does not lead up to even temporary heart and lung insufficiency, as is the case in running and other similar exercises. This only occurs sometimes on the turf during racing.

Swimming.—By virtue of our ability to retain a certain volume of air within our lungs, the specific gravity of our bodies is somewhat lighter than that of the water, so that we are enabled to float in it. In order to move about in the water or propel our bodies, certain muscular movements are necessary. In the forward movement the extensors of the legs are principally engaged, very much after the same manner as in the jump. The legs are drawn up close to the body, the thighs forcibly abducted, the legs extended and quickly brought together, feet describing a semicircle during the maneuver. The body slides forward owing to the pressure exerted by the inner surfaces of the legs upon the cone of water included between them. During this movement the arms must be extended in the forward direction, the fingers of both hands touch each other to facilitate the movement. Next follows the drawing up of the thighs close to the body by a contraction of the psoas and the iliacus, and this is counteracted by the simultaneous movement of the arms and hands backward and downward, effected by the muscles of the shoulder plate and the broad back muscle or lat. dorsi. The pectoral muscles attract the arms again toward the sides of the body, and the extensors of the arms throw the hands forward. In the meantime the back muscles keep the back hollow and the head well out of water. The respiratory muscles keep up a vigorous movement of the thorax, in which they are supported by the lateral movements of the arms.

The suddenly increased frequency in the number of respiratory movements made on the part of the lungs, which are needed to satisfy the suddenly increased want of oxygen in the blood, is proof of the large number of muscles that must be employed in the act of swimming. We have here, indeed, all the muscles of the trunk and extremities engaged simultaneously, and not only mere groups of them. And there is no difference either in the degree of their contraction between any of them nor in the

amount of work which they are doing; all the muscles are engaged in working to their best possible ability. It is this that makes swimming one of the best general exercises there is. Swimming, therefore, makes the greatest possible demands on the functions of heart and lungs, and presupposes that both are strong and sound; on the other hand, when carefully taught, swimming is one of the best gymnastic exercises for both of these organs.

Vigorous swimming, particularly against current and wind, is very apt to bring on pulmonary and cardiac insufficiency before the fatigue of the muscles engaged in the exercise is a complete one. This double insufficiency would occur still sooner were it not counteracted to a certain extent by the temperature of the water surrounding the body and which has a cooling effect. By filling our lungs well with air, we are able to float on the surface of the water and rest when fatigued.

Diving or swimming under water is one of the severest tests on the heart, especially its right or venous side, for besides the large amount of air already taken into the lungs immediately before diving, which distends it and compresses its capillaries at the same time, thus offering a great impediment to the circulation of the blood through the lung, we must, in addition, take into account the pressure upon the thorax which the column of water, resting above the body, exerts on the outer surface of the chest walls. Thus we find that diving, just as much as the lifting of heavy weights, is one of the few exercises which may easily cause over-distension of the heart muscle. Persons having had rheumatism or suffered from some infectious fever, or who have indulged excessively in the use of alcohol and tobacco, must take such exercise with caution.

While walking, running, jumping, dancing, riding and swimming form the natural and, at the same time, simple bodily movements, the remaining movements of the soldier, such as climbing, pole-vaulting, fencing, all apparatus work, calisthenics, bicycle riding, skating, etc., are the combined body movements in which upper and lower extremities are engaged more or less simultaneously, and form mutual support and aid to one another. In such combined movements we find, in the first place, that they engage a greater number of muscles at one time than is the case with the simple and more natural movements. Thus, in climb-

ing, we have the muscles of the shoulder plate and of the arm strongly supported by the muscles of the inner side of the thighs and legs. In pole-vaulting, although most of the work being undoubtedly done by the arm muscles, those of the lower extremities come into play in jumping off the ground. In bilateral fencing we find pretty nearly all the muscles of the body and the extremities engaged, although in exclusively right-handed fencing it often occurs that we get a unilateral hypertrophy of the respective arm muscles, and, on rare occasions, also, curvature of the spine occurs.

Bicycling is more nearly a natural exercise in spite of its being performed on a machine. It is but a modified walking, and exercises more especially the step-musculature with this difference, that the muscles of the seat remain rather inactive as compared to the muscles of the thighs and those of the legs. For the development of the calf-muscles, bicycling and mountain-climbing are about equally good. Bicycling, it must be remembered, puts very heavy demands on heart and lungs on account of the tendency of some of the riders to get over the ground as fast as possible, as is done in scorching.

Wrestling, like swimming, engages all the muscles of the trunk and of the extremities, but while in swimming the resistance offered to muscular action and to be overcome is uniform, that which is required during wrestling is irregular and not always easy to foretell; it trains the eye to quickness in action. The same is true for bayonet exercise. There are, besides, a number of these combined movements as distinguished from the natural movements, many of which are done in the gymnasium. From a study, however, of the anatomy and physiology of the natural movements described in the foregoing pages, their intent and purpose may easily be inferred. The same is true of the few exercises that are comprised in what is known as the setting-up drill, and to which, as a general thing, much more importance is attached than it deserves.

The classification of these free movements, as well as those done on the different apparatuses in the gymnasium, must be left to the judgment of the instructor or trainer and the purposes he has in view in applying them to the individuals under his care and in his training. It should always be kept in mind that there must be a definite aim as regards every individual's development,

the exercises being merely a means to attain a certain well-conceived end.

THE PERSONNEL TO BE TRAINED.—All military training naturally divides itself (1) into the training of the individual soldier and (2) into that of a large body of men as a whole. The object of the former is to train the man, develop his individual physique, loosen his joints, strengthen his muscles, raise the standard of his health and endow him with endurance in walking, running, jumping, etc.; the object of the latter consists in the employment of such means as are best calculated to still further develop the qualities acquired in the former and assure their continuance and maintenance. The principal exercise employed to attain this end consists in marching, which shall be brought up gradually to approach the conditions that obtain in an actual campaign and resembling in all its details those of war.

It is of fundamental importance that the military trainer should, first of all, know the *personnel* which it is his duty to train, and for the purpose of obtaining that much desired knowledge, a thorough examination must precede the training itself. At Annapolis, the instructor of gymnastics, acting as recorder, had the advantage of being always present when these preliminary examinations were made, and consequently knew as well as the director himself what were the good as well as bad points about the physiques of the different individuals who were about to begin training.

The first impressions of a new class upon both the director and instructor, although they had already passed the Medical Board, were often not exactly encouraging, and if this was the case with cadets, how much more so must this be the case with recruits. The ideal of symmetrical physical perfection, which is gradually formed in the mind of an experienced trainer as the result of years of experience, is so rarely reached by even a single individual out of many that annually present themselves, that it appears to him more and more evident from year to year, and as his experience increases, that without individualizing, his task would be a hopeless one. For even among an apparently well-selected class of people, round shoulders, slight spinal curvatures from faulty positions during childhood, with unsymmetrical hips and shoulders, drooping heads and bow-legs, deficient develop-

ment of the back and arm muscles, may all have their representatives in even so small a number as one hundred. Fortunately, though, as long as heart and lungs are perfectly sound, these are, nevertheless, attended with results often quite remarkable in the hands of judicious and careful trainers who know the importance of individualization and have experienced the great advantages of the use of special exercises. Training, perhaps more than anything else, requires patience, for many of the most uncomplimentary, even intemperate, remarks made by onlookers often concern men of the greatest promise, and those who turn out in the end the very best subjects not only as regards endurance in drills but also on parade.

Almost the first criticism that will be made, not only by the public, but by officers as well, when watching a military drill or parade, is sure to be with regard to the symmetrical carriage of one or two persons in the ranks. It is no doubt a great desideratum that every officer and man in the ranks should learn to so control his anatomy as to form a homogeneous link in the chain of his bataillon; that he should be ever conscious of the fact that he is one of the wheels of this great, living machine, and that he alone would be all-sufficient to destroy the beautiful symmetry of a parade, or that upon him alone might depend the success or failure of an assault. Indeed, a knowledge of the importance of concerted action on the part of every man within the ranks is looked upon as one of the pedagogical results of any and all the drills in which many men are engaged at a time. A parade, however, should never be looked upon as the *end* in the education of the soldier, but only as one of the *means* to that end.

The chief qualifications that determine the military fitness of a man are height, weight, lung capacity, strength, chest circumference, and their mutual relations to one another. These, together with a pair of good lungs and a sound mind, are necessities. Whenever the material to choose from happens to be unusually large, other points of a less essential nature may be taken into account. But much greater care and attention of course must be exercised in the physical examination of cadets than is done in the examination of recruits, for obvious reasons.

With the view of establishing a series of more reliable and trustworthy standards, and giving greater definiteness, as it were, to the extent and amount of certain recognized normal and,

therefore, allowable deviations, an attempt was made a few years ago to work out the averages with their normal deviations in certain dimensions, such as height, weight, circumference of chest, etc., from a large number of measurements that had been recorded during a previous period of thirty years, and arrange these data according to age. The measurements from which these calculations were made having been originally taken from normal subjects, that is, cadets who had passed the Board of Medical Examiners, it ought naturally to follow that the deviations calculated from an average standard previously established for certain dimensions must also be within strictly normal limits. This, indeed, was found to be true, and the tables which were published in the report of the Surgeon General to the Secretary of the Navy for 1893 have since been in constant use at the Naval Academy as aids in the examination of cadets.

In a general way, however, it is perfectly true and in accordance with our own experience, when Leitenstorfer states that "in spite of such attempts having been made, the physical fitness of the soldier cannot be expressed by any mathematical formula." The eye, experienced in training as well as examining men, may often be relied on when numbers fail to do so. No amount of experience, on the other hand, will absolutely always insure against failure in regard to individual cases.

Military training in general.—The training of men for military purposes and achievements while differing in many ways from that employed for the various sports and athletic events, has also, on the other hand, many features in common with it. The aims and ends of all training must include a higher standard of health, greater endurance, more will power and an ultimate increase in weight. All these may be attained by means of well systematized muscular exercises.

By measuring a large number of professional foot-ball men, runners, oarsmen, infantrymen, cavalrymen and sailors and averaging their measurements in different dimensions, we would undoubtedly arrive at certain figures corresponding approximately to what might be called (but is not) a type for each of these classes of men. Yet these figures at best would only represent anatomical facts, and, as such, tell us nothing with regard to the physiological functions which each type represents. I can conceive of the possibility of the measurements of two or even

three out of the above number of types approaching each other so closely that, so far as measurements alone are concerned, they might all be placed into one and the same class or type. One group of measurements out of these three might represent a typical foot-ball player, the second an infantryman and the third an oarsman. These three are chosen as instances because they happen to present much the same development as regards the muscles of their backs and legs, consequently would be most likely to be placed into the same class from measurements alone and without taking into account their previous history. Yet it is not to be expected that the one could be substituted by either of the other two so far as his skill and his special accomplishments are concerned, and the training for which has given him his physique, without material detriment or danger to the success of the game, race or maneuver. This would show that we may arrive at the same ends, so far as muscular development alone is concerned, in many different ways and by more than one method of training; it also shows that a well-developed foot-ball player is not necessarily a good soldier, nor a thoroughly trained soldier a perfect oarsman, in spite of the muscular development of each being much the same. All three have been trained for different purposes and are consequently *physiologically*, if not anatomically, different.

We know, furthermore, that the period of training for any of the sports must never be extended over a time of six to eight weeks on the average if we wish to avoid the consequences of overtraining. The period of training a soldier is extended over a much longer space of time. The various branches peculiar to the calling of the soldier or man-of-war's man require as much training and leave as sure an imprint on their anatomy and physiology as do the most complicated muscular movements. An essential difference in the training of a soldier as compared to that of a man-of-war's man is, moreover, to be found in the period of life at which each begins to learn his calling. A sailor begins young, and before his period of normal growth and development is completed; while the soldier does not generally enlist before he is twenty, an age at which growth, in height at least, is nearly at an end. Both need, therefore, different treatment, not only as compared with each other, but also as compared with athletes generally. This fact, however, remains true for all, namely: The

highest degree of efficiency within the limits of a man's capacity having been reached, it cannot be long maintained, either with or without detriment to his health, and a period of comparative rest must follow, and is quite imperative after the period of training. Nor does the training of a soldier or sailor mean that he should constantly be kept at the highest point of physical endurance and efficiency. This sort of training is to be undertaken only periodically and, in Europe, generally precedes the great annual fall maneuvers.

While it is perfectly true, and must be admitted, that in adults, the period of training being over, the former condition of bodily physique returns in about the same period which was spent in training, it is equally true and quite significant that a certain permanent and lasting addition accrues to the organism as regards height, weight, lung capacity and muscular strength over and above the normal *in persons who had not reached the adult stage of their normal physiological development*, or about 21 years of age, when undergoing training.

And, even in adults, long after the condition of their highest physical efficiency and endurance has passed off and their former natural physique has returned, certain permanent gains can be noted which, according to Leitenstorfer, are as follows:

1. "An acquired freedom in the articulations."

2. "An increase in muscular development which, under the influence of a moderate amount of exercise, may be maintained for years."

3. "Increased co-ordination of muscles; a certain muscle-memory has been created, by means of which all the movements are quickly recalled, even after years. Ex., the mere sight of a musket will cause the veteran to go through all the movements which its contact with his hands seems to suggest."

4. "A larger lung capacity and a stronger heart with freer circulation."

5. "Moral strength from consciousness of power. In other words, the normal standard of his health and strength has been raised far above the former average, he lives on a higher plane and has acquired more tone throughout his entire organization, which is ready at any moment to be again trained, in a short time, to the highest possible degree of efficiency and endurance."

INDIVIDUAL TRAINING.—For the best of reasons, Leitenstorfer insists that "it is not, and must not be, the object of individual training to at once fit the soldier for enduring long and exhaustive marches, such as he is expected to perform in the end and to endure without danger to his health or the condition of his training." In this respect the training of the soldier is different from that which is employed for the runner, foot-ball player or oarsman. These are trained for an event which is soon over, while the soldier must be carefully trained for a career which may last for years. To start with, the most careful and gradual development of the entire step-musculature is to be aimed at, and this object can be attained only by a precise analysis of the step itself and by emphasizing every movement necessary to complete it. The soldier must be taught to walk and step out vigorously, get over the ground at the rate of 80 centimeters per step, endure such walking for days and over great distances, his body being heavily laden, and arrive in the field still fresh enough to go into battle. There is no calling, no athletic sport, which puts such heavy requirements on the step-muscles as are demanded from the soldier taking to the field. In view of such demands and requirements, we must find it most logical that the step-musculature of the recruit should receive the greatest possible attention from the very beginning. There is but one disadvantage, and a serious one, in this method of exclusively training the step muscles without having due regard to the other parts of the body. Such training must result, and generally always does result, in the asymmetrical development of the body as a whole, and direct measurements have proved this to be the case. It is found that the muscles of the back and legs are developed at the expense of the muscles of the arms and upper parts of the body.

While, then, says Leitenstorfer, "the systematic exercise or practice of the different and distinct movements of the dismembered step has proved itself to be the most valuable gymnastics for the development of the step-musculature, it must be supplemented by exercises which tend to develop the arms and the upper part of the body, and should not be too rapid." The soldier needs good muscular development of his arms, his shoulders and his neck for the purpose of an erect, strong and enduring carriage for climbing fences and other obstacles as well as for shooting.

Those who have had experience in examining and measuring recruits will no doubt agree in that there exists a greater difference or discrepancy between the strength of the arms of different persons than between their legs. We have even found it one of the most difficult undertakings to develop the muscles of the arms of different individuals and the upper parts of their bodies, in order to correct faulty carriage, naturally resulting from such weakness. These muscles seem, at least, to respond less promptly to the influence of exercise than do those of the lower back and lower extremities.

The soldier who is supposed and expected to carry a heavy knapsack on his back, with leather straps over his shoulders, needs good muscular cushions to keep those things from pressing upon the chest-walls, thus impeding his respiration and chafing the bones, at the same time allow the free and unhampered movements of his arms.

All this proves the necessity and importance of attending to individual faults in recruits. A company of recruits may, not inaptly, be compared to a chain in which every link possesses a different degree of tensile strength. While it is impossible to so train and develop every recruit that each one shall be the exact equal of his fellow in both endurance and strength, as can approximately be done with the chain, this must, nevertheless, be our aim; for it has been said, and truly so, by experienced generals, that the rapidity of the advance of an army is not the rapidity of the swiftest, not even that of the average, but that of the slowest; just as the strength of the chain is not that of its strongest, but only that of its weakest links. It is of great importance to advance the whole army, every man being of consequence, especially so in modern warfare.

In the light of facts such as these, is must seem clearly absurd and contrary to the end in view, to train five or ten per cent of a bataillon to do athletic feats, while the remaining ones look on and applaud, and it should never be forgotten that the highest aim of individual training of soldiers is to produce as nearly as is in our power and as our means will allow that much desired homogeneity as regards endurance, in the ranks and out of them, which will enable the commander of troops to arrive in the field of battle with his entire army, and not leave the greater portion behind on the field, exhausted and broken down, thus inviting sure defeat.

I cannot do better for the purpose of showing the startling inequalities in many respects that exist among recruits of even the same age, than reproduce a table from Leitenstorfer. Measuring a bataillon of men, he found the following results, which are exhibited in the succeeding table:

Dimensions.	Limits.		Difference.	Measurements of		Average of Bataillon.
				Strongest.	Weakest.	
Height	177	157	20 cm.	173	165	162
Chest circumference	95–103	78–85	17 cm.	95–103	80–86	84–91
Weight	81	50.5	30.5 kg.	81	55	61.5
Upper arm	30	24	6 cm.	30	24	26.5
Thigh	53	45	8 cm.	53	46	49
Leg	38	31	7 cm.	38	31	34.5

If such discrepancies, as are exhibited in this table, are found among men of the same age, what are we to expect to find among recruits in whom even age is not only not a uniform factor, but the most variable of all factors, such as we find them in our army, navy and militia. In the face of such difficulties as these the task of the training officer seems indeed almost hopeless. We must also, in view of the fact that all recruits must sooner or later form a homogeneous whole, clearly see how useless it would be to train a few for the performance of feats of strength and neglect the rest. A high average working capacity of the bataillon must be the constant aim held in view, and to attain this end the weakest among the men are just the ones that require not only the greatest attention, but also the very best experience and judgment. All those, therefore, who are from absolute lack of natural endowments entirely unfitted to benefit from or endure the necessary training with its hardships must be early discovered and promptly excluded, lest they shall become a useless burden on the bataillon and dead ballast on its hands.

All these things require the experience and skill as well as personal devotion of the expert military trainer. A high average working capacity of the bataillon as an entirety, a high degree of uniformity in strength and endurance among the individual soldiers so as to approach almost the ideal condition of homogeneity, a perfect machine, equally strong in all its parts and without a single flaw; these are the objects of individual training.

Diet and Nutrition.—The human body consists, on the average, of 59 parts of water, 9 parts of albuminous substances,

6 parts of glue, 21 parts of fat, 5 parts of mineral matters and 1 part made up of extractive matter (creatin, creatinine) and carbohydrates (glycogen and sugar).

During the life of the organism the relative quantities undergo a constant change and readjustment in accordance with the requirements of its daily needs. No thought can be launched into the world, not a single finger can be raised, except through the agency of the fine fabric of brain and muscle substance. But accompanying the performance of both mental and muscular work there goes hand in hand a substantial loss of matter, which loss must be made good so that the disturbed balance may be restored. The craving, known as hunger, is but the outward expression of something needed inside, and the various forms of fatigue are nothing more nor less than so many different kinds of hunger located and felt in those tissues that need nourishment most, and consequently cry for it the loudest in the only way they can. It will be seen, therefore, that the relation which exists between any kind of training and nourishment is both intimate and important. Careful weighing has always resulted in showing that there occurs a loss in weight in the beginning of training for any of the athletic sports, but this initial loss is followed just as quickly and surely by a more steady and, finally, permanent gain. Thus the average gain in weight of twenty-five naval cadets in training for foot-ball within the period of two months amounted to 3.28 kilos. Out of this number, two showed no gain at all, one lost one kilo, the lowest gain was two kilos, the highest six kilos. According to Leitenstorfer, the increase in weight of recruits after three months of training was on the average 3.27 kilos, or almost exactly the same as was found in the cadets.

The initial loss and the subsequent gain in weight may always be observed during the training of recruits in which the diet is sufficient and can be controlled. The loss of weight is, very naturally, always greater in the well nourished and fat people, less great in the thin and poorly nourished ones. In order that the gain in weight shall be normal, attention must be paid to the quantity as well as quality of the food. Whenever recruits are undergoing hard training and perform an unusual amount of muscular work, their rations must be adapted to their needs, or a loss in weight, instead of a gain, is always sure to follow. It

has been repeatedly shown in Germany, whenever soldiers were maneuvering, the maneuvers approaching the conditions of war, on a peace ration, that they all lost weight, and consequently also the benefits of the training, which it, nevertheless, was the intention they should receive. Such loss has been known to reach an average of 2.78 kilos (L.).

We must agree with Leitenstorfer, who remarks, "Since the war ration for the army is, by regulation, a higher one than that allowed on a peace footing, it stands to reason that no one has any right to exact the unusual requirements of war maneuvers from soldiers who has not also, at the same time, the necessary authority to increase the soldier's rations." That the living organism in all its various functions *can be improved* by the judicious exercise of such functions under the strict observance of the laws of physiology, lies at the bottom of all training, mental as well as physical. But increased work demanded from either requires increased supply of fuel, if not the machine itself is to be worn out and ruined.

As a general rule, and for purposes of training, that diet is the ideal one which nourishes the body without burdening the stomach; in other words, a diet which supplies the necessary amount of albumen, fat and carbohydrates in the form which is most easily digested and assimilated. The growing muscles need albumen, and since during muscular work the fats and carbohydrates are being burned up, it becomes necessary in the first place to increase the amount of fat in the food. An increase in the amount of carbohydrates is not so necessary, because all the rations contain a superabundance of those foods that contain them. The most frequent errors and the most serious mistakes in the composition of rations occur with regard to the quantities of fat which is allowed, and which, in most of them, is much below what it ought to be.

The most valuable albuminous diet for growing muscle is fresh meat, especially fat beef. The vegetable foods that contain a large percentage amount of albumen, vegetable albumen, are not so easily digested; besides, they contain a large surplus of carbohydrates and are consequently too voluminous a diet for the purpose of supplying the soldier with albuminous food in this form. Fat beef, then, is the most valued albuminous food for men undergoing training.

During muscular work the muscle is not itself consumed as long as there is at hand a sufficient supply of fats and carbohydrates. An increased quantity of fat must be taken by those who are expected to do an increased and increasing amount of muscular work. Fat is the best fuel, and its presence protects the growing muscle from being itself consumed. Both fats and carbohydrates must, of course, be given in a mixed form. In case the meat happens to be too lean, the necessary fat must be added in the form of bacon or butter. No form of fat, however, is so easily digested, and consequently so little of a burden for the digestive organs, as is the fatty meat from our domestic animals.

It is evident, from what has been said, that an officer in command of a number of men is not doing his whole duty when he is satisfied to merely fill the stomachs of his men; he must also look after the quality of the food which they consume.

Another point of great importance is the quantity of water which is taken by men in training. Water must not only be pure and wholesome, but a certain quantity of it is absolutely necessary to a perfect diet. But the percentage composition of all foodstuffs shows that they all contain a not inconsiderable amount of water, and therefore it would not seem necessary that much water need be drank in addition to that which the food already contains. Indeed, it may be urged as one of the objections to the common ration of the soldier and man-of-war's man that it is too sloppy, too wet. Soups and similar slops, while no serious objections under ordinary conditions, during training are to be reduced on account of their occupying too long a time for their absorption, and thus form an unnecessary burden or ballast.

It has long been known that horses fed on moist grass, clover or oats, sweat on making the least exertion and have but little endurance. A large quantity of water taken with meals dilutes the food material as well as the gastric juice; digestion is much delayed and the absorption of the digested food is much retarded; the stomach is distended and unnecessarily burdened with ballast; the tissues themselves become too moist, if not altogether œdematous, and the combustion of fats and carbohydrates remains incomplete, while the deposition of adipose tissue is favored.

Besides the proper quantity and quality of a diet, we must have

a frequent and wholesome change. The most hungry stomach will refuse to be satisfied at times with the same food for all time. An exhausted soldier will often, even in a state of hunger, refuse the proffered food, preferring to go to sleep without taking the much needed nourishment and suffer the consequences, if there is an unwholesome sameness about the bill of fare.

The temptation of consuming too large a portion of the daily ration at one meal is also to be guarded against, and a more judicious division very desirable. As regards coffee for breakfast in the morning, it is undoubtedly a most desirable adjuvant. But it must be coffee, and not one of the numerous substitutes of coffee. Then, again, it must be remembered that coffee is only a nerve-stimulant and not a food. Coffee simply stimulates the motor nerves and cannot take the place of any other part of a perfect diet. In order to give the coffee or the tea the significance of a nourishing meal, we must add milk and sugar to it and eat bread and butter with it, with perhaps some bacon.

Alcohol.—We have seen in the foregoing when water is taken in too great quantity during training its use is anything but useful. It retards the effects of training and, in the fully trained, lessens muscular tension, overburdens the heart by increasing blood pressure, overtaxes the activities of the lungs, the sweat glands and the kidneys, consequently depresses the working capacities and the endurance of the men.

A still greater danger, however, arises from indulgence in alcoholic beverages. These affect the men in training, not only as water does, by unnecessarily increasing their ballast and retarding their digestion, but by a direct destructive action upon their energies and endurance. The question of the effects of alcohol and its derivatives on human organization has of late years been extensively studied in all parts of the civilized world, and is rapidly approaching the condition of final settlement among scientific physiologists. Physiologists are agreed that alcohol directly attacks the substance of the brain cells, and after a brief period of stimulating them to abnormal activity, finally paralyzes them completely. The prolonged influence of alcohol destroys these substances not only temporarily, but attacks their structure upon the integrity of which their continued activity depends. Experiments have established the further fact that alcohol is not a food, and cannot take the place of one. More-

over, the idea held formerly that its presence in the blood would retard the combustion of nitrogenous material, has also been entirely disproved, and it was found that instead of retarding it, it causes an increased combustion of these substances. Practical experiments made with alcohol on large bodies of men who had to endure long and fatiguing marches during the war of the rebellion have also conclusively shown that it is disadvantageous. We know of its disastrous effects in hot climates, and of the dangers of its use in the polar regions. Therefore, alcohol is not entitled to form any part of the rations of men in training, especially of soldiers.

MENTAL TRAINING.—An experience of five years at the Naval Academy, where I was given charge of physical training, has taught me among other things the great value and influence which the mind exercises over muscular work. There is, in my opinion, no system of exercises, no code of law, physiological or municipal, no regulation or discipline, that does not need to possess elasticity sufficient for an occasional and timely relaxation, a special interpretation and application to suit the present and ever changing condition of men's minds, if otherwise we would depend on the best quality of their work. In superintending the exercises of the cadets and sometimes noticing how mechanically these were gone through with, and how far off their minds apparently were from the work, it was perfectly surprising to note the difference in the performance of the exercises that immediately followed a short rest, a few encouraging words, an earnest and well intended appeal to their manliness and an explanation as to the higher purposes, meaning and significance of the work in which they were engaged.

I am firmly convinced that the difference in the effects on the human organism to be obtained through muscular work from the different systems of gymnastics, is at least as much due to the personal influence of the individual instructor over the minds of his men, as it is due to the special inherent virtues of the particular system employed and as compared with another.

Different minds need also different treatment, and the experienced trainer, in order to obtain the same results in all cases, modifies his treatment to suit the natural requirements of the individual. The mental discrepancies which exist among a lot

of men are at least as great as the physical ones are, and since, as we have seen, muscular work is directly dependent on the condition of the mind, treatment of the latter should engage as much the attention of the trainer as does the development of the body.

There is, for example, the city boy, up to all sorts of pranks and always bent on mischief, trying to get everybody into trouble except himself; alongside of him we find the good natured but slow, if not stupid, country lad, still laboring under the depressing influence of the newness of his surroundings, and falling an easy prey to the pranks of the former. These must not any more be treated alike than they can be pressed into the same mould, at least not for the purpose of producing the best results of individual training. The sailor boy who, as a general rule, begins his training from four to six years earlier in life than the soldier, requires in this respect also much more careful training than does the soldier.

But over and above the merely temporary mood, the mere frame of his mind, stands the soldier's natural mental endowment, his intelligence and inherited mental capacity. This also must be trained and cultivated. Both soldier and sailor must be educated in order that they may become intelligent machines, and whenever a time should come when the necessary word of command is missing, that they shall go on working in the way they should without any command. The better the education, the better also will be the results of individual training. Moreover, while it must be freely admitted that in a military organization and for purposes of military discipline, it is absolutely necessary that a man should learn to subordinate his own *will* to that of his superior, his superior or trainer should remember that the man's *self respect* is not to be crushed out of him during his training, but must be carefully preserved and developed.

Thus it will be seen that the successful training of the individual soldier implies a certain amount of intelligent instruction, and forms in its entirety a most difficult and responsible sort of problem. *Caeteris paribus*, we may sum up by saying that the best soldier will be the one who has received the best mental training; and the best instructor the one who has the highest conception and the profoundest and broadest knowledge of his duty and his calling, coupled with the ability of communicating both to his men. The greatest and most successful commander

of troops will be he who has himself acquired the most thorough knowledge and appreciation of the principles involved in training his men, and is thereby enabled to constantly keep in the closest possible touch with the needs and requirements of the ever changing conditions of his troops during the great maneuvers of an actual campaign. A maneuver of so large a body of men as a commander is responsible for handling at these times, is an experiment in which every detail concerning the care of men must receive the greatest and promptest attention by the commander himself, in order that it shall be successful, because nothing can be done without his order, hence, also, his responsibility.

Training of the Troops.—The recruit having been gradually and systematically developed, understanding the use of arms, having, moreover, been thoroughly drilled in all the movements of the company, bataillon and the regiment; in other words, having received all the constitutional benefits and advantages to be derived from individual training, he is now ready and prepared to join larger bodies of troops. The training of the troop, as distinguished from individual training, consists, according to Leitenstorfer, "in the systematic and gradual increase in the efficiency for marching and in the maintenance of a high average ability and endurance."

Though we must accept it as a fact that the highest possible physical efficiency and endurance which a man is capable of reaching through individual training cannot be maintained for any desired length of time, either with or without danger to his health, it is nevertheless one of the outcomes of individual training that the soldier is kept in such a condition of physical perfection, so as to enable the commander to force his troops up to the point by a short period of training whenever the exigencies require this to be done. The recruit, moreover, cannot be considered ripe for troop training until he has successfully completed his individual training and passed through the various company, bataillon and regimental drills.

The period of troop training should never be extended over three weeks, since experience has shown that such efficiency and endurance, as is the aim of this training, cannot be maintained beyond this period without the troops passing into the condition of overtraining with its attendant dangers.

In the German and other European armies this begins in the fall of the year and ends with the great maneuvers, which, as we all know, approach in severity and in their demands upon the endurance of the soldiers the conditions of war as nearly as these can be anticipated and reproduced.

The greatest danger that threatens the maneuvering of large bodies of men of course is heat-stroke, but since the discussion of this would lead us too far, it is perhaps just as well to leave this subject for a future occasion.

Troop training must be regarded as the finishing touch upon a soldier's training, and a short period of rest, generally two weeks, should always follow.

Have we anything in this country that would approach such training? Is it desirable that we should? Are the requirements and conditions which we have to meet sufficiently different from those prevailing in other countries that we can afford to dispense with the complete and thoroughly efficient training of our soldiers and men-of-war's men and militiamen? Is there anything we could substitute for such training? These are some of the questions which we must ask ourselves, and I know of none in relation to the personnel of our military establishments that are of such *real* importance whenever the *efficiency* of the service is urged and made a prominent feature in the argument.

It is not for me to suggest reforms with regard to the technical training of our soldiers and men-of-war's men, and far be it from me to lose myself in vain and useless criticisms of existing conditions of things, but from a point of view of training and developing the physique and endurance of those whom we look upon as the bulwarks of our defense, much as yet may be learned from an examination into the methods employed by other nations.

DISCUSSION.

A Proposed Uniform Course of Instruction for the Naval Militia. (*Continued from page 228.*)

Lieut.-Commander Arthur B. Denny, Massachusetts Naval Brigade.—Mr. Dohrman's paper is of great value to naval militiamen, since it emphasizes some of the hindrances to their development and points out a remedy.

The present uncertainty of the range of usefulness of the naval militia is a damper on the enthusiasm of both officers and men. While the part which the naval militia has to play in assisting the suppression of domestic order is pretty clearly defined, so that an officer can be moderately sure where it is best to direct his efforts in preparing for emergencies, it is not so clear what would be the function of any particular unit in case of war.

As Captain Taylor has said in a most admirable letter to the Navy Department, special duties must be assigned to each State organization, and "no general plan for all alike can be drawn up." The problem for each commanding officer is not only "for what would it be well that my command be prepared," but also "what is the most valuable part of the whole for which I shall begin to prepare in the limited time which can be given."

In solving this problem it is desirable that this preparatory work, whether it be much or little, be directed by a considerable professional oversight, so that those taking part in it would be assured that their efforts were being made where the results would best fit into a general scheme. Then, too, the proposed lecture staff would get an intimate knowledge of just how far and in what lines each organization could be depended on for service, and this knowledge could hardly fail to be of more value to the Navy Department than the rather indefinite information which it now necessarily has.

Mr. Dohrman's scheme for winter work errs, if at all, in being too broad. Such part of the men's leisure time as can be given to military work is pretty well taken up now with drill and unavoidable routine. Undoubtedly a certain amount of information could be and has been obtained, but the many plans and working drawings with recommendations for structural and other changes would require more men with both technical skill and a command of time than many organizations would be able to furnish.

I agree most thoroughly with the author's recommendation to have systematic and progressive instruction given by a lecture staff working on a large general plan modified to meet the case in hand, and I hope the idea will be carried out by the proper authorities.

Lieutenant James Otis Porter, Massachusetts Naval Brigade.—That a uniform course of instruction for the naval militia is necessary all are

undoubtedly agreed, and the essayist suggests an excellent plan for such instruction.

His recommendation that a board be appointed to formulate a system, and that a bureau of instruction be created, should be carried out, but it must be remembered that most of the officers and men of the naval militia are in business and that their time is necessarily somewhat limited. Too much, therefore, should not be attempted.

The reconnaissance work, so admirably begun and carried out by the New York battalion, should be systematically taken up by all, and the work should be under the direction of the navigating officers of the several organizations.

A list of vessels for the auxiliary fleet should be made and data collected as to size, tonnage, speed, indicated horse-power. When such vessels are yachts, the places where they are laid up in the winter should be kept track of in order that they may be brought to their ports of fitting out as suggested by Captain H. C. Taylor; but to obtain the information and to make the drawings that the essayist recommends would, to my mind, be impracticable. So much time would be consumed in work of this kind that no opportunity would be had for the actual drill and instruction of the men.

I would sugest that instead of the creation of small traveling libraries, each State should buy all the books required and issue them to its naval militia.

Systematic instruction and guidance by the Navy Department is what the naval militia needs, but it must not attempt too much.

Commander J. W. Miller, 1st Naval Battalion, N. Y.—The argument presented by Mr. Dohrman is so entirely in accord with the views of the New York naval militia, and with the work of its battalion during the past four years, that little room is left for criticism, and the discussion would be unnecessarily prolonged if I should give even a synopsis of the correspondence and articles written by the various officers of this State upon the lines laid down by the lecturer. I would, however, call the attention of those interested in the naval militia and its development as a coast defense, to the *Forum* of October, 1891, April, 1896, to reports to the Adjutant-General of New York, 1891 to 1897, to the Journal of the U. S. Artillery, Vol. IV, No. 3, and to the Proceedings of the Association of the Naval Militias of the United States, 1895 and 1896. The article in those Proceedings, entitled "Information and Boat Reconnaissance Work," by Lieut. Wm. H. Stayton, is especially worthy of notice.

If the lecturer has found a "vagueness and haziness" among members of organizations as to what their duties would be in time of war, the reason for such uncertainty lies not in the fact that the officers of the naval militia have not had a definite scheme, but that lack of facilities has prevented them from developing their ideas, and that, unfortunately, they have had to devote the first few years to overcoming local antagonism, as well as prejudice in certain quarters of the navy. The regular service, with its years of training, can scarcely understand the difficulties

which surround the development of a new force with a divided allegiance to state and government. The laudable enthusiasm of recruits desirous of gaining a sailor's experience had to be guided in order to turn them from the more congenial work at sea towards the immediate and important duty of coast protection. The natural desire of the citizen-sailor is for tours of duty on board the new men-of-war. This desire should not be altogether thwarted if the country wishes to enlarge the naval militia to a force proportionate to its true importance. It is also essential that the enlisted men should have a rudimentary knowledge of naval customs and exercises, which is only to be gained by an occasional cruise in a government vessel; but such cruisers must be secondary to the main object for which the naval militia is formed, that object being the defense of the coast line and the waters of the State. It cannot be too often reiterated that the distinct purpose of the organizations is to develop them both in discipline and numbers as a portion of the "second line of coast defense." As the marine policy of the country becomes more definite there will be added to this "second line of defense" a national reserve under the direct auspices of the General Government. The creation of such a naval reserve will naturally follow the development of the naval militia, and from the reserve the navy will be enabled to draw its war complement of officers and men. It is most reasonable to suppose that if we once created a naval militia of even a few hundred men in each State it would concentrate around it the seafaring interests of the various ports. The question, therefore, presents itself, how can the four thousand men now in the naval militia be instructed, not only to perform their legitimate duties, but to increase the small number to a force commensurate to the needs of the country? The fulfillment of this object is not at all difficult if the service will do its share. The responsibility as to whether the navy shall keep the militia closely under its fostering aid or permit it to drift away to the army is most weighty.

A special office should at once be created at Washington under the Assistant Secretary of the Navy, to be called that of the "Naval Reserve and Naval Militia"; it should have at its head an officer of high rank, and under his exclusive control a moderate-sized man-of-war; this vessel should make the rounds of the ports for the purpose of instruction and inspection. A large number of the new torpedo-boats should also be under the orders of this officer, one or two of them being stationed in each of the harbors where a properly organized naval militia exists. During nine months of the year these boats should be actively engaged in teaching individual militia crews the use of torpedoes and mines, the officers commanding them to work jointly and in harmony with the State forces. The man-of-war and torpedo-boats should be assembled during the summer months for different tours of duty with each of the battalions or with those in contiguous districts. A squadron of this nature, under the command of navy officers trained to the work of obtaining military information, will result in a similar and definite course of instruction, the details developing themselves quickly. Sufficient data have already been given by the lecturer, and notably by Captain Taylor in his letter

to the Assistant Secretary of the Navy dated December 12th, 1896. My experience goes to prove that the scope of work for proper coast defense is so great that the difficulty will be in concentrating it, and that the navy itself has much to learn concerning the interior waters of the country. There is no service which will help the education of the regular officers more than that gained by commanding torpedo-boats. In addition to this active fleet, the reserve fleet of the navy, instead of being laid up at one navy yard, should be distributed to each of the larger ports, provided the State authorities will give them wharf accommodations free of charge. It is difficult for the writer to understand why the Department should think seriously of placing all the reserve fleet at one yard, when, by distribution along the coast, the present naval militia could be at once increased from four thousand to at least treble that number. The argument for docking the ships in fresh water amounts to little compared to the instant development of a *personnel* for the navy. Our minds have run too much to *materiel*, and it is high time that patriotism, enthusiasm and local knowledge should be fostered and assisted in every locality from Maine to Texas and on the Pacific coast. With the reserve vessels laid up in different harbors, having on board a skeleton crew and commanded by younger officers thoroughly alive to the necessity of recruiting the naval militia, with the battalions drilling on board the ships during the winter months, we will shortly have a force which, in addition to its local information, has gained a fair knowledge of the intricacies of the modern man-of-war. These laid-up vessels will also be a focus around which a national naval reserve will be formed under conditions outlined by the writer on various occasions. The plan is perfectly feasible and only needs the co-operation of the regular service. The expense is trivial, the result will be immediate.

Replies to Criticisms of Essay on Torpedo-Boat Policy.

[See No. 81.]

Lieut. R. C. Smith, U. S. Navy.—I find I have not been sufficiently explicit on one or two points. The word policy has been used in the title in a perhaps limited sense to indicate building policy. This technical meaning seems to have passed current to a certain extent since the report of the so-called "Policy Board" on ship construction a number of years ago. With this understanding, it is apparent that torpdo-boat tactics could not have been discussed at any length in the space assigned, which proved no more than sufficient for the subject proper.

Another point in which I have been somewhat misunderstood is my advocacy of strengthening the bow for ramming. I did not intend to go as far as recommending ramming as a prime object. I do not believe that opportunities for ramming should be sought, but that if occasion arises, as in the sudden discovery of a vedette launch or torpedo-boat of not too large a size directly in the path, the option of ramming

may prove of great value. Of scarcely less value is the added security in case of accidental collision bows-on. Many accidents attest the great weakness of the boats in this regard. With the strengthening I advocate, and the straight knife bow, I am confident that a vedette launch could be cut in two without material injury to the rammer, and that the weak side of an ordinary torpedo-boat could be laid open with every possibility of escaping fatal injury on the part of the attacking boat; and in torpedo warfare these are greater odds than are usually demanded.

My estimate of 5 to 10 pounds for every ton of displacement is based on an interior 18-inch (in width) belt of wood and steel applied to the Cushing's bow on either side for 15 feet abaft the stem, the total weight of which was 600 pounds. The knife edge for 18 inches abaft the stem was poured in solid with resin. This weight corresponds with the lower estimate of 5 pounds. By using 10 pounds per ton and all steel instead of wood, the strength could be doubled or trebled. This is all the more possible now that the bow tube is abandoned in torpedo-boats.

This interior water-line belt was suggested as the result of an experience of the Cushing's in the upper Delaware river in December, 1895, when she came near being frozen in for the winter. Ice of two to three inches thickness had been broken up in a thaw and then caked solid to a maximum thickness of five or six inches in a sudden freeze. Without any protection and with steam that in clear water would have given 15 knots, she passed through 20 miles of this ice. The result was a few frames bent and one or two cracked, and the plates of one-eighth inch steel bent in between the frames. No rivets were started and no plate was punctured. There was no injury beyond the second bulkhead at 15 feet from the stem. The interior belting subsequently applied was located in wake of the maximum bending of the plates and frames and securely braced from side to side. The details were approved by the Bureau of Construction. I understand that during the past winter the Cushing encountered ice in large cakes of three inches thickness in Narragansett Bay and Providence river which she cut through with absolutely no injury to herself and with steam that would have given 16 knots in the open. Is not this a great thing for a light torpedo-boat to be able to do, and at the expense of the weight of less than one torpedo? I hope that our other boats may all eventually be equipped with the same or a similar contrivance.

In conversations on this subject I have frequently heard the argument that it would be better to employ a tug to go ahead, or to rig a temporary ice plow over the bow. In time of war both of these means would usually be out of the question. Even in peace times boats might be caught, as the Cushing was, with no tug or carpenters available and the ice rapidly getting thicker. Then in case of a collision, accidental or otherwise, there would obviously be no time for preparations. I think this matter of added strength in the bow is a little like the Texan's revolver; he did not want it often, but when he did he had quite a positive need for it.

I shall now take up a few of the criticisms individually.

Lieutenant Eberle (page 56) suggests lashing the target across an old sailing launch. Of course it was contemplated to use a boat for the target, as otherwise towing at speed would be an impossibility. This was in fact Captain Evans' original suggestion. Mr. Eberle's plan of requiring the torpedo-boat to discharge her torpedoes at the same time is a good one. With dummy heads, the ship herself could be the target.

With regard to his discussion of torpedoes in battle-ships (page 57), I doubt if they can be given up by any nation as long as the ships of other nations carry them. Of course the submerged positions are the safest in every way. Then it must not be lost sight of that the range, speed, accuracy and safety in handling of torpedoes are constantly improving, and that there is less reason now than ever for dispensing with them. If other nations could be brought to discard them it would be all the more reason for us to retain them. In a discussion of Lieutenant Niblack's prize essay of last year I gave my views on this point at some length.

The statement (page 58) that I believe vessels of the Yorktown class would make efficient scouts does not convey my meaning. Our Yorktowns are altogether too slow, but there are some foreign vessels of the class that make 23 knots.

I cannot agree with Assistant Naval Constructor Dashiell (page 63) that the 1-pounder is a suitable gun for the smaller type of boat. The principal use of the vedette launch is to give warning of the approach of torpedo-boats. She might by a lucky shot disable one of them. On the other hand, I believe that the torpedo-boat should not pay the least attention to her. Run over them if they get in the way, but do not answer their fire; it will only create more confusion. Even when the vedette launches open fire and discharge rockets it may be some time before the ship picks up the torpedo-boat. If the latter joins in the firing she only hastens her own discovery. Her best plan is to keep right on in silence as long as there is the shadow of a chance of reaching the main object, hauling off only when positively discovered at some distance outside of torpedo range.

The object of the gun armament in torpedo-boats is, to my mind, to afford a weapon for use against other boats. A boat, if unarmed, might be destroyed by her inferior in respect to torpedo armament. It is an object then to carry weapons that could be used effectively in circumstances similar to these. Automatic 3-pounders, as has been shown, can be carried on the weights allowed, and they have therefore been recommended.

As to the remarks about the destroyers (page 63), I believe that destroyers should be met by destroyers and not by gunboats and cruisers. All experience as far as peace manœuvres go has proved the latter course delusive. And I think we should have a type fit to send anywhere with the fleet, which of course points to the large boat.

Mr. Dashiell and Mr. Eberle are in accord as to the undesirability of installing torpedoes in large ships. It would certainly simplify matters to leave them out, but that is not a good argument. Nothing now is

simple. The side that has the intelligence to use the most destructive and most complicated weapons with the greatest skill will win.

I am in most hearty accord with Mr. Dashiell's remarks as to naming the boats (page 65). Foreign nations name powerful battle-ships after great admirals. It is belittling our great names to give them to torpedo-boats. The stock of young heroes will last for a long time. I myself am in favor of employing names of insects, fishes and animals. The only drawback is that the English have largely depleted the available supply.

Assistant Naval Constructor Gillmor's remarks (page 153) are rather difficult to reply to. He finds nothing to commend in the essay, but he does not make clear what types he would substitute for those he condemns. I gather by inference that he is an advocate of the Forban. If he is, I can understand that we are scarcely in accord. But as the Forban has been improved on and practically abandoned by her builder, notwithstanding the splendid performance of her machinery, it is not necessary to attach any great importance to Mr. Gillmor's advocacy.

The reply to the argument at the top of page 154 as to the 30-knot boat and the 26-knot boat is obviously that if the former is able through excellence of design of hull and machinery to command a greater proportional economical endurance, then by a reduction of machinery weights to the amount required for 26 knots the endurance will be still greater for the same coal; and by applying the saving in machinery weights to additional coal there will be yet another gain. From the very fact as stated by Mr. Gillmor that the economical speed varies so greatly in different boats it is obvious that there can be no comparison except at *full speed;* and I am of opinion, moreover, that this is just the comparison that is most needed.

His argument in the next paragraph does not hold for the reason that there is no object in building boats with a lower speed than 22½ knots. In fact I have shown that all the required features, such as armament, endurance, sea-worthiness and the rest, for the objects sought can be obtained in a 24-knot boat. Then what is to be gained by going lower? If all these features could be assured in a 30-knot boat, then so much the better; but it is something that has not yet been done. It is true as he says that flaming does not appear until the maximum power is approached; but of course the water disturbance depends only on the model and actual speed, and has nothing to do with the maximum horsepower it may have been decided to put in the boat.

It is to be noticed that in all of this he is opposing my argument for a moderate speed and is himself advocating a high speed, necessarily at the expense of other features. I shall refer to this again.

Next follows an argument as to speed in a sea-way (page 154), which, if it means anything, is to the effect that because under certain weather conditions a small boat may do as well as or better than a large one, it is the part of policy always to build small boats. Of course boats like ships have their periods, and they do not always strike them together; but everybody knows that generally speaking greater size means greater possible speed, endurance, comfort, sea-worthiness and carrying capacity;

and it is on account of the very different duties required, as shown in the essay, that it is thought desirable to make such a marked difference in the two types.

Bearing in mind Mr. Gillmor's criticism of my boat of moderate speed, attention is asked to this extract from his remarks (page 156):—"Expressed in a few words, the author's conclusion is that we should start in this mad race for torpedo-boat speed about where England now is and accept their latest type in one case, and in the other almost a duplicate of the last thing which the English newspapers chose [sic] to call a torpedo-boat." This is certainly quite opposed to my whole discussion of the speed question, and taken in connection with his previous criticism of my advocacy of moderate speed, puts me at a loss as to his meaning.

Lieutenant Niblack (page 157) does not think I have taken enough account of tactics as affecting the design of boats. Has he not possibly lost sight of the difference between torpedo-boats and ships? Ships must manœuvre together and fight in conformity with tactics, and hence tactics will exert a great influence on their type and homogeneity, both of battery and hull. Torpedo-boats may also cruise together and engage other boats in conformity with tactics; but when it comes to the supreme object of their existence, the attack of ships, tactics in the sense that Mr. Niblack apparently takes it, that is the art of manœuvring together, amounts to very little. The only tactics I have seen advocated with any show of reason is to separate and make a concerted attack from different quarters under cover of darkness or mist.

If the different features are determined for this purpose alone, the boats will be nearly enough alike to engage in the German close manœuvres at full speed, which are useful for training the eye and developing the nerve, but could not possibly be used in action. I believe at the manœuvres some years ago they had a division of torpedo-boats steaming along shore by day in close order at high speed and shelling a troop of cavalry on the beach. This was pretty, no doubt, and it required some sort of tactics to carry it out, but it had nothing to do with torpedoes.

I have tried to show in the essay that the scheme of division boats presents few desirable features from our standpoint. I may not be sufficiently acquainted with it. While Mr. Niblack is abroad he will have opportunities of looking into both these questions, and if there is really much of value in the German system and tactics I for one shall be glad to hear what he may have to say about them.

I am very much in favor of any exercises that will give officers skill and confidence in handling their boats, and I think any risks should be taken that do not involve the probable loss of the boat or lives of the crew. If these risks are not taken in time of peace, officers will not know how to take them in time of war. Consequently every opportunity should be utilized, such as navigating narrow waters without a pilot, going alongside of docks at speed in various weathers, making attacks under the search-light on dark nights, and manœuvring about a vessel under way.

PROFESSIONAL NOTES.

TO FIND THE GREAT CIRCLE COURSE BY INSPECTION.

By Lieutenant J. B. Blish, U. S. Navy.

If in the "astronomical triangle" *PZM*, for *M*, the celestial body, is substituted *N*, the place to which a vessel is bound, then the angle at *Z*, the "azimuth angle," becomes the "great circle course" from *Z* to *N*.

This angle can be taken by inspection from the "azimuth tables" by substituting (1) the difference of longitude for the "hour angle"; (2) the latitude of *N* for the "declination," when the "true bearing" will be the "great circle course" from *Z* towards *N*, measured from the elevated pole.

The azimuth tables issued by the Navy Department are computed for the sun only, and consequently their use for this purpose is limited to those cases where the place to which the vessel is bound is within the tropics.

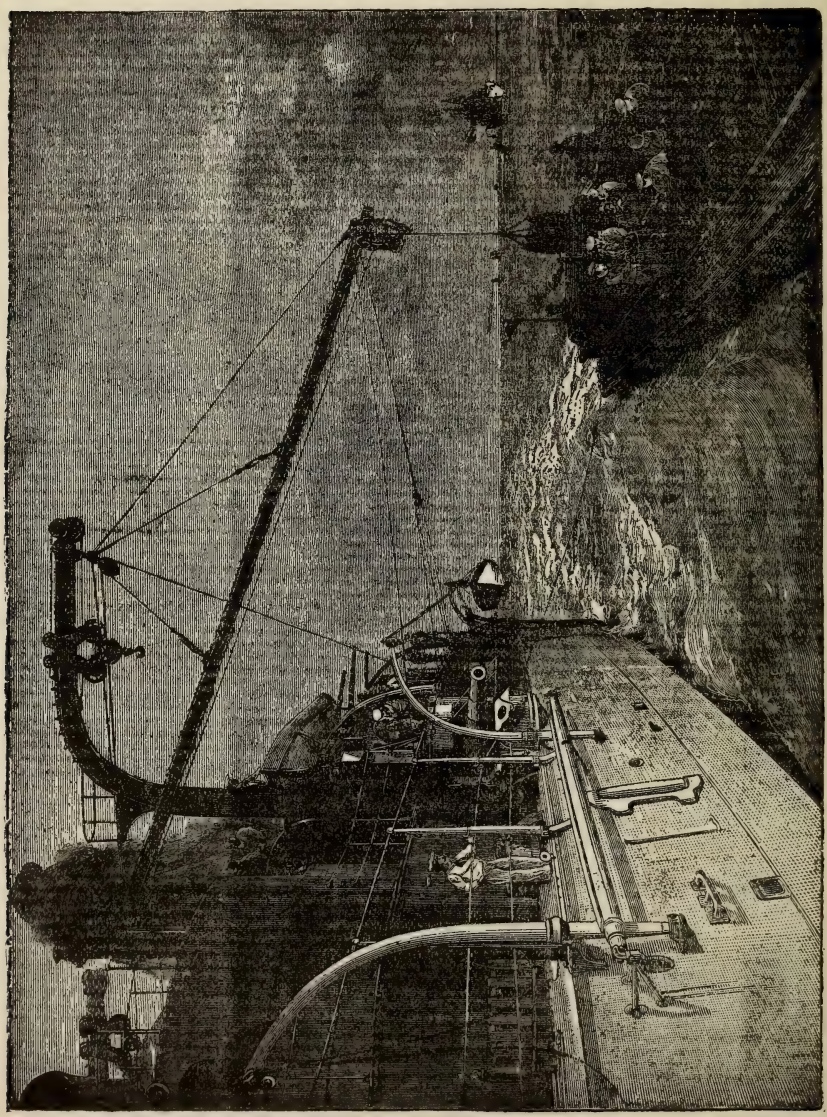
An extension of these tables to greater declinations would not only increase the number of stars available for azimuths, but by making this simple method available in all practical latitudes would tend to bring *great circle sailing* into common use.

COALING WAR-SHIPS AT SEA.

In dwelling upon the advantages conferred upon the war-ship by the introduction of steam, it must not be forgotten that the new power imposed one very serious burden which is making itself increasingly felt as the speed and size of modern ships continue to increase. For whereas the masts and sails of the frigate were good for a cruise of indefinite length, the boilers and engines of the modern cruiser or battle-ship are available for propulsion only so long as there is coal in the bunkers. The radius of action of the steam-driven ship is determined by her capacity for carrying fuel and her distance from an available coaling station.

There are perhaps no operations of a naval war in which this limitation of the steam battle-ship has caused greater inconvenience than in the work of blockading an enemy's port. In the days of the sailing frigate a ship could lie for months, if need be, in the blockading line, and the full strength of the fleet was maintained unbroken for months at a stretch; but in a modern blockade it would only be possible to count upon a certain percentage of the ships as available, the others being absent in turn, taking on coal at the nearest station. It has been estimated that during the blockade of Charleston in the Civil War fully one-quarter of the ships were absent at any given time for coaling purposes.

The same difficulty presented itself at the blockade of Charleston harbor during the recent naval manœuvres. Ships whose draft was not over 15 feet entered the harbor, where the water was quiet, and were coaled from



barges lying alongside in the usual way; but had the larger vessels, such as the Indiana, Maine, New York and Columbia, drawing from 20 to 26 feet, required recoaling, they would have been obliged to steam away

to Port Royal or Newport for the purpose. As it was, all of the vessels that took on coal were obliged to leave their position in the blockade, and its efficiency was impaired in proportion to the number of vessels absent at any one time.

With a view to overcoming the difficulty, the U. S. S. Massachusetts was recently fitted out at the New York navy yard with a coal transporter, which will enable her to take coal either when at anchorage off a blockaded port or when steaming at slow speed in moderately calm water.

-Carriage locked to the beam, the load being raised or lowered.

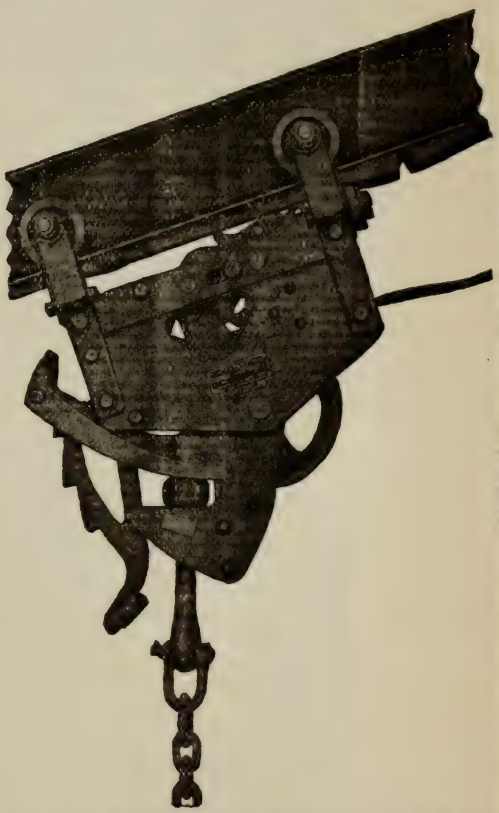


FIG. 2.—Load locked in the carriage which is free to travel along the beam in either direction.

The Temperly Transporter is the name by which this new form of hoisting and conveying device is known. The device consists of a traveler running on a suspended beam, which reaches out over the coal barge, towed abeam at a distance of 20 or 30 feet, and is carried from one of the boat cranes of the battle-ship. This beam, which is 60 feet in length, and weighs about 3000 pounds, is suspended from a strap, attached to the crane by four steel guys, and it is prevented from swinging fore and aft by means of other guys which lead inboard and are made fast to the

deck of the vessel. A novel form of self-locking carriage is employed, which travels upon the lower flanges of the beam, and is capable of traversing its entire length. The beam is pitched at an angle sufficient to cause the carriage to run out by gravity, and a single hoisting rope coiled about the barrel of the steam winch serves at once to operate the carriage and hoist the load. The rope after leaving the drum is led to a sheave which is secured at the point of suspension of the beam, from thence to a pulley at the higher end of the beam inboard, and from there it passes around a sheave in the carriage and terminates in a hook to which the bags of coal are attached.

In operation we will suppose that the carriage is at the lower end of the beam over the barge, where it is locked automatically to one of the stops on the under side of the beam, the locking gear of the carriage being then in the position shown in the first figure. After the hook is secured to the coal bag, the hoisting rope is drawn in by the winch, the load rises rapidly to the carriage, where a catch on the hoisting chain, striking a lever, automatically locks the load to the carriage and releases the car from the stop above-mentioned on the under side of the beam. This position is shown clearly in the second figure. The further inhauling of the hoisting rope causes the carriage to travel rapidly up the beam. The stops on the under side of the beam are spaced five feet apart, and the carriage is drawn up until it passes that one which is located over the point where it is desired that the bag shall be delivered. The winch is now stopped and reversed, and the carriage moves back until it is arrested by the engagement of the latch, which is shown at the top of the carriage with this particular stop. The dropping of the latch into the stop automatically releases the load from the carriage and it is forthwith lowered to the deck. The bag is then unhooked, an empty bag is put on in its place, and the operation is reversed, the empty bag being run down the full length of the beam and delivered to the barge. The whole operation is performed in less than a minute, and it requires no skill upon the part of the operator. The long reach of the beam permits coal to be taken from a vessel of any description, which may stand off from the battle-ship a distance of from twenty to twenty-five feet, and the operation may be carried out in any sea in which it would be safe for two boats to lie at anchor at that distance apart. As the transporter is supported entirely from the battle-ship, no part of it can be injured by the rolling from the two vessels.

It will be evident that the coaling ship may be towed at a moderate speed parallel with the war-ship, and that the operation may be carried out with equal success under such conditions. The French navy, which uses this system of coaling extensively, made a successful trial of coaling the Richelieu while she was steaming under the headway of six and a half knots an hour, and they were able on this occasion to transfer one hundred tons of coal in three hours.

After experiments extending over a period of two years, the British Admiralty has now decided generally to adopt the Temperly Transporter for use in battle-ships and first-class cruisers. It is probable that the apparatus would have been adopted before had it not been for its awkward length and the difficulty of stowing it clear of the working parts of the ship. The trials, however, have resulted in most favorable reports, and the commanding officers of the vessels in which the transporter has been tried are unanimously of opinion that the time and labor saved when

coaling ship far outweigh the inconvenience occasioned by stowing the gear away. Apart from this, it has been found that the transporter will enable a torpedo-boat or destroyer to fill up with coal from her parent ship when both vessels are steaming at a fair rate of speed, providing, of course, the sea is moderately calm. During a series of tests, forty tons of coal an hour were handled in bags by this device.

LIQUID FUEL.

[Paper by R. Wallis, read at a meeting of the N. E. Coast Institution of Engineers and Shipbuilders at South Shields on February 10, 1897.]

The writer's experience with this form of fuel has principally been petroleum residues on board of steamships, and the contents of this paper may, therefore, be taken as applying more particularly to its use in this direction.

The application of liquid fuel for the purpose of raising steam in boilers is now no longer in the experimental stage, a large number of boilers, both on board ship and ashore, being fired with this fuel, and there is no doubt that, as the numerous oil fields in the various parts of the world develop, its application will rapidly extend.

In addition to the oil wells of Southern Russia and Pennsylvania, oil has been found in varying quantities in most countries all over the globe. The late Mr. B. G. Nichol, in his paper on this subject before this Institution in 1886, mentions the countries in which petroleum had been discovered. Since that time several of these oil fields have been developed and are now producing petroleum in considerable quantities, especially those of Peru, Burmah, Sumatra, and Beluchistan.

The principal source of fuel oil is Russian petroleum residuum or "astatki"; this is the oil remaining in the distillery apparatus after the lighter naphthas and paraffines have been distilled over. Russian crude petroleum yields a very much smaller percentage of burning oils than American crude oil, as is shown in Table I, but fuel oil in Russia, where "astatki" is used for this purpose, is cheaper than in America, where crude oil is used.

The percentage of the various oils that, with the perfected process of distillation now used, could be obtained from Caucasian naphtha is as follows:

TABLE I.

		Density at 17 degs. Centigrade.	Percentage.
Light oils		0.725	3
Illuminating oil,	kerosene	0.822	30
	solar oil	0.863	14
Lubricating oils,	spindle oil	0.895	10
	machine oil	0.908	16
	cylinder oil	0.915	5
Oil fuel		0.93	17
Loss		....	5
			100

American oils contain a very much higher percentage of burning oils, about 80 or 90 per cent., instead of only about 50 per cent., as above.

The first steamer to use liquid fuel was the S. S. Constantine, on the Caspian Sea in 1870, and in America it was used on the steamer Thoroughfare in 1885. The first steamer to cross the Atlantic burning oil as fuel was the S. S. Baku Standard in January, 1894.

In addition to the petroleum oils, the following oils have also been used as fuels: shale oil, blast furnace oil, creosote, green, and other tar oils.

On the table are examples of Russian astatki, American crude petroleum, crude petroleum which has been exposed in a lake to the influence of the atmosphere for twelve months, creosote oil, heavy and light tar oils.

Comparing the value of coal and oil as fuel, it will be found to vary considerably according to the quality of the fuel and the circumstances under which each is burnt, oil doing from 1½ to 2½ times the work of an equal weight of coal; taking the average conditions, the results of extended experience with astatki and crude petroleum show that these oils will be found to do twice the work of coal.

TABLE II.

	Specific Gravity.	Chemical Composition.						Heating Power, British Thermal Units.	Theoretical Evaporation.		Evaporation in lbs. from and at 212° Fah. by experiments.
		Carbon.	Hydrogen.	Nitrogen.	Sulphur.	Oxygen.	Ash.		Lbs. from and at 212°.	Lbs. air required per lb. 23 %.	
PETROLEUM.		%	%	%	%	%	%				
Pennsylvania heavy crude	.886	84.9	13.7	...	....	1.4	...	20.736	21.48	14.56	.....
Caucasian light crude....	.884	86.3	13.6	...	....	0.1	...	22.027	22.79	14.74	.....
Caucasian heavy crude...	.938	86.6	12.3	...	....	1.1	...	20.138	20.85	14.28	.....
Refuse	.928	87.1	11.7	...	....	1.2	...	19.832	20.53	14.12	16
Crude average, 15 samples	.870	84.7	13.1	...	....	2.2	...	20.233	20.94	14.29	.....
Refined average.....	.760	72.6	27.4	...	.....	.....	...	27.531	28.5	17.93	.....
Scotch blast furnace oil ..	.920	83.6	10.6	...	0.1	9.4	...	18.590	19.2	.....	.....
COAL.											
Welsh, 37 samples.....	1.315	83.8	4.8	1.0	1.4	4.1	4.9	14.470	14.98	.....	9.05
Newcastle, 18 samples ...	1.256	82.1	5.3	1.3	1.2	5.7	3.8	14.432	14.94	.....	8.01
Derbyshire and Yorkshire, 7 samples.....	1.292	79.7	4.9	1.4	1.0	10.3	2.6	13.582	14.06	.....	7.58
Lancashire, 28 samples ..	1.273	77.9	5.3	1.3	1.4	9.5	4.9	13.552	14.03	.....	7.94
Scotch, 8 samples.....	1.260	78.5	5.6	1.0	1.1	9.7	4.0	13.804	14.29	.....	7.70
Average British, 98 samples	1.279	80.4	5.2	1.2	1.25	7.87	4.0	13.968	14.46	11.34	8.13

Table II shows the analysis of various oils and coals, together with their calculated calorific and evaporative values. This shows a value for oil of only 1½ times that of coal, and therefore some cause other than that of comparative heat value must be looked for to account for the result of a value of two to one in favor of oil fuel which is found in practice. This difference may be accounted for to a great extent by the following causes:

1. The combustion of the liquid fuel is complete, whereas that of coal is not; consequently in the former case there is no lost heat in smoke or soot.

2. There are no ashes or clinkers, and consequently no fires to clean, with accompanying loss of heat and drop in the steam pressure; the steam pressure and revolutions of the engines being maintained at one point throughout the voyage.

3. The boiler tubes are always free from soot and clean, and therefore always in the best condition for transmitting the heat from gases passing through them to the water of the boiler.

4. The temperature of the escaping gases may be considerably lower than is required to create the necessary draft for coal firing. With coal, the air has to be drawn through the bars and the fire in the furnaces; by natural draft this requires a temperature of the escaping gases about 600 degrees to 700 degrees Fahr. But in the case of liquid fuel there are no bars or thick fire for the air to force its way through, and the required amount of air can be drawn through the furnaces by a much lower uptake temperature, about 400 degrees to 450 degrees Fahr. being in most cases sufficient.

5. The admission of air to the furnaces being under complete control, and the fuel being burnt in fine particles in close contact with the oxygen of the air, only a very small excess of air above that actually necessary for the complete combustion of the fuel is required. With coal, in order to ensure as complete combustion as possible, a very much larger excess of air is required.

In addition to its higher calorific value, liquel fuel has many other advantages, especially on board ship.

Stowage.—A ton of coal will occupy about 45 cubic feet of bunker space, and a ton of oil will require about 40 to 45 cubic feet. Assuming that both coal and oil will require the same bunker space per ton, then since one ton of oil fuel is equal to two tons of coal, the bunker space necessary to steam the same distance at the same speed is only one-half. In addition to this, there is no lost space caused by the projection of frames, stringers or beams. Also portions of the ship which, if used as coal bunkers, would be inaccessible, can be utilized for the stowage of oil.

Trimming.—This is altogether dispensed with, the oil being run or pumped into the fuel tanks through a deck connection, and beyond the opening and closing of the distributing valves, no other attention or labor is necessary for the shipment of the fuel; this makes a considerable reduction in the labor, cost, and time occupied. When at sea the oil either gravitates to the furnaces, if the tanks are above them, or is pumped up if below, and no trimmers are required.

Stoking.—The sprayers require very little attention after they are once adjusted, and one man can attend to a large number of furnaces; and there being no ashes or dirt to remove, the stokehold staff can be reduced to a single man for each watch in any ordinary vessel, or in a small vessel the sprayers can be attended to by the engineer on watch in the engine-room, as is done in many of the vessels on the Caspian Sea.

There are also no firing tools to repair or fire bars and floor plates to renew, and the absence of smoke and dust enables the ship to be kept cleaner.

Regarding the various methods which have been adopted for the burning of liquid fuel, these may be divided into three systems: 1, Furnaces into which the oil is run or dropped and burnt without gasifying or spraying; 2, furnaces in which the oil is first wholly or partially gasified; 3, furnaces into which the oil is sprayed.

1. This is the oldest form of burning oil, and is illustrated by the following examples:

The step or cup form of furnace, and is the latest form of a very old method of burning oil.

The pan furnace of Biddle, used in North America in 1862.

Richardson furnace, patented in 1864. The bottom of this furnace is covered with ordinary slacked lime, which is kept saturated with the oil to be burned.

Audouin furnace, first tried in 1865, consists of a large number of small tubes from which the oil is constantly dripping, and is carried into the furnace and burnt by the draft through the openings in the front.

The furnaces of St. Claire-Deville, 1868; Wagenknecht, 1870; Kamenske, 1869; MacKine, 1865; Verstract, 1868, and Paterson, 1878, are all similar to one or the other of the above furnaces. The defect of all these is that the air is not brought in close contact with the burning fuel, with the result of imperfect combustion, accompanied by dense black smoke.

2. Shaw and Linton's gas furnace, patented in America in 1862.

Dorsett and Blythe gas furnace, tried in England in 1868 on board the steamer Retriever. It may be observed that the disadvantage of all gas furnaces is that when using heavy residual oils the tarry deposits rapidly stop up the passages and pipes.

3. The furnaces into which the fuel is sprayed can be divided into three distinct classes:

a. Flat slit sprayers.

b. Sprayers in which a jet of steam or air meets a jet of oil at an angle.

c. Circular sprayers.

Several attempts have been made to spray the oil by other means than that of the steam jet in order to overcome the difficulty of making up the fresh water drawn from the boilers in the form of steam.

Air under pressure, especially if heated, has been found to give good results, but the flame is shorter, giving a more intense heat for a short distance than the flame from a steam sprayer. More air than steam is required for the spraying of the oil, and the air jets are more noisy than the steam. The danger of an explosion of oil gas in the furnace and combustion chamber when lighting up, especially if the furnace has been stopped for a short time only, is very much greater with air than with steam sprayers.

Comparing the economy of air and steam sprayers (notwithstanding the drawback of having to make up the water lost in steam used by the sprayers), the steam sprayers appear to be the most economical, and are certainly the type mostly in use. The arrangement of the whole of the steam sprayer installation is exceedingly simple and not liable to derangement or breakdown, whereas the compressed air system is complicated and the risk of breakdown increased by the addition of the air compressor.

The essential requirements in a sprayer are: 1, The oil and steam openings must be so arranged that the oil can be sprayed in the finest particles possible; 2, the steam consumption of the burner must be as low as possible; 3, the sprayer must be constructed in such a manner that it can be easily and quickly taken apart for cleaning and quickly replaced; 4, the noise should be reduced to a minimum.

During the writer's experience and tests with a large number of sprayers, he has found that the " Rusden-Eeles " sprayer conforms more

nearly to these requirements than any other. The spray is very fine; in fact, with astatki the flame can be regulated so as to have the appearance and character of a gas flame. The steam consumption is low, and the construction allows it to be quickly and easily cleaned.

In the later sprayers the blow-through cock is omitted, it being found easier and more effective to take the tube out and clean it than to blow the oil space through with the steam.

In arranging an installation, the principal points are: 1, The superheating of the steam; 2, ample area in the fuel pipes, especially if heavy oil is used, and in the case of very heavy oils they may be required to be heated; 3, the supply tank should be placed in such a position as to ensure a constant and steady supply to the burner.

Brickwork in the furnaces should be arranged in a manner as to ensure the complete combustion of the fuel in the furnace and to prevent the too rapid cooling of the furnace after the flame is extinguished.

In some cases, where the boiler is placed in confined space or there is not height enough to obtain a steady pressure on the burners from the supply tank, the oil may be pumped direct to the burners if a controlling valve is connected to the steam pipe of the pump. This valve will regulate the speed of the pump automatically and maintain a constant pressure in the oil supply pipes, no matter how many sprayers may be in use.

In relighting a furnace which has been extinguished for a short time lies the greatest danger of explosion of oil gas and the accompanying back flash from the furnace doors. Any small leakage or drip of oil finding its way into the heated furnace gasifies and forms an explosive mixture with the air, and if the lighting-up torch is introduced into a furnace under these conditions an explosion is sure to take place, and the person introducing the torch is very possibly burnt. Before lighting a furnace it should be well blown through with steam and care taken to see that the steam jet is open first and the torch placed in the furnace before the oil valve is opened, in order that the spray may ignite as soon as it enters the furnace. If these precautions are taken there is not the slightest danger of explosion, even if fuel with low flash-point is used.

The result obtained by several experimenters, that the average evaporation of liquid fuel is twice that of coal, has been confirmed by a long series of experiments conducted by the writer under the instruction of the Wallsend Slipway and Engineering Company, Limited, with various sprayers.

The boiler, which is of the ordinary marine type, evaporated with coal fuel from 7 to 8 lbs. of water from and at 212 degrees Fah. for each pound of coal burnt, the uptake temperature being about 450 degrees Fahr. with Russian astatki. The evaporation was from 13 to 16 lbs. from and at 212 degrees Fahr. per pound of oil. The following are the average data from some experimens with a Rusden and Eeles sprayer, and a heat account from the same data:

Kind of liquid fuel, Russian astatki:

Specific gravity	0.9
Chemical analysis (approximate)	87 per cent.
Carbon	12 "
Oxygen	1 "
Temperature of stokehold	60° Fahr.
Temperature of escaping gases	450° "
Weight of steam required to spray 1 lb. of oil	0.3 lb.

Assuming that the air contained 23 per cent. of oxygen, and that the excess of air over that required for complete combustion passing into the furnace was 20 per cent., which would be about correct, for the slightest reduction of air caused smoke to issue from the chimney:

	Heat Units.		Equivalent Evaporation from and at 212° Fah.
Total heat from combustion of 1 lb. oil :			
Carbon, .87 x 14,500..... =	12,615		
Hydrogen, .12 x 62,032..... =	7,444		
		20,059	20.7
Heat cost in waste gases at 450° Fah. :			
Carbonic acid gas..... 3.19 lbs.	269		
Nitrogen .....10.72 "	909		
Water vapor from combustion..... 1.08 "	1,452		
Water vapor from sprayer.. .30 "	29		
Surplus air, 20 per cent.... 2.78 "	257		
		2,916	3.0
		17,143	17.7
Heat lost in radiant heat, etc.....		1,687	1.7
Heat absorbed by water in boiler.....		15,456	16

In addition to the firing of boilers, liquid fuel has been used for various other purposes. Mr. Urquhart, in his paper before the Institution of Mechanical Engineers, shows how he has successfully applied it to scrap welding furnaces.—*The Steamship, April, 1897.*

THE DUM-DUM BULLET.

Surgeon-Captain G. S. Mansfield, Medical Staff, has drawn up an instructive report on the experiments with the special Dum-Dum bullet carried out before the commander-in-chief in India, at Meerut, in December. These experiments, which were intended to demonstrate the amount of "set-up" and "stopping power" in the bullet, were made, says the *Times of India*, on the carcases of freshly-killed sheep tied up in various positions, some with the fleece on and others with the outer skin removed. Except in one instance, the range was 200 yards, and the sheep were fired at broadside on, diagonally, and facing the shooter, in the last-named position the long axis of the body being exactly in line with the line of fire. The most remarkable result of the experiments was the large size of the "wound of exit." One bullet fired at an unskinned sheep broadside on passed between two ribs, making an entrance wound no larger than a big pea, but after shattering one of the spinal vertebræ, it smashed two ribs and produced an exit wound as large as a crown-piece. Another bullet fired under similar circumstances entered the abdomen behind the last rib, making a wound of entrance as large as a three-penny bit. On its exit a hole was torn in the opposite wall of the abdomen the size of a large orange. Yet another bullet fired at the same sheep pierced the lower jaw at its angle, making a hole in the skin no bigger than a pea, but on examination it was found that the bone was completely shattered. The report gives details of several other shots. One in particular may be noted, that in which the bullet, passing through the thigh, struck the pelvic bone, which apparently offered such resistance

that an exit wound 2½ inches in diameter was the result. Surgeon-Captain Mansfield mentions as particularly important, the case of a bullet which entered through the front of the shoulder-joint by a very small opening, and, passing through the joint, completely disorganized it. The articular ends of the two bones were smashed into over a dozen pieces and there was great loss of substance. This wound may fitly be compared to a shot through a man's wrist or knee, and under similar conditions the bullet would be certain to immediately disable him, excision of the joint, or more possibly amputation of the limb, being the only remedy available. It does not require an expert's knowledge, says our contemporary, to perceive that such wounds, if inflicted on a human being, must necessarily put an effectual "stop" to his advance, even if they do not always prove fatal. The efficacy of the Dum-Dum bullet is specially vindicated by the character of the wounds which only affected the soft parts. From these wounds Surgeon-Captain Mansfield infers that a bullet penetrating the muscular tissue only, such as that of the human thigh, will "set up" sufficiently to cause a severe wound, quite enough to effectually stop the progress of the man or the horse struck. It has been noted that all the shots except one were fired at a range of 200 yards. The exception was that of a shot fired at 50 yards from the animal. It struck the sheep's abdomen, soft parts alone being injured; yet though the wound of entrance was small, the bullet on emerging tore a hole the size of an orange. This shot exemplifies beyond all reasonable doubt the superiority of the new bullet over the old one. Bullets manufactured by the new method do not produce clean-cut wounds at close range, as was the case with the old bullets, but are now shown to possess an exceptional "stopping power."—*United Service Gazette, May 8, 1897.*

TESTS OF ARMOR AND SHELL.

[United States.]

Built-up Armor.

Washington, D. C., May 11, 1897.—The Navy Department has made an interesting test to determine the efficiency of two thin armor plates superimposed on each other in close contact, as against the resisting power of a single plate of their combined thickness, the result demonstrating to the satisfaction of the Department that the single thick plate is a considerably more effective barrier against armor-piercing shells with service charges than the thin plates. The experiment was made for the purpose of determining whether in case the emergency should arise it would be practicable to provide certain armor for the three new battleships by having thin plates made to be used in lieu of the thick plates, which cannot be produced within the limit of cost, $300 per ton, fixed by Congress in the Navy Appropriation bill. The thin plates, it was decided, could be manufactured by any one of a considerable number of steel makers and could be produced in large quantities at short notice at $300 per ton, or less.

The tests were made at the Indian Head Proving Grounds of two nickel steel, reforged, face-hardened plates, superimposed one on the other. The gun used was a 10-inch breech-loading rifle, No. 26, on a station hydraulic mount. The charge was 237 pounds of C. G. 2 powder. The

striking velocity, measured by the chronograph, was 1952 foot seconds and the striking energy was 13,223 foot tons. The projectile was a Carpenter 10-inch armor-piercing shell, No. 267 of lot 1, hardened to 0.5 inch below bourrelet, the weight of projectile being 500 pounds. The distance between gun and plate was 394 feet.

The plates were 6-inch face-hardened nickel steel plate B 525 and 5.5 inch nickel steel face-hardened plate B 504½, both supplied by the Carnegie Steel Company. The 5.5 inch plate was the port re-entrant plate which had been recently tested. The 6-inch plate had been previously used, 20 impacts for the tests of 6-inch armor-piercing projectiles having been made upon it. The 5½-inch plate was against the structure; the 6-inch plate was outside of it and toward the gun. They were lapped over each other for a distance of 4 feet 3 inches. No greater flat surface was available, previous impacts on the 6-inch plate interfering. The results obtained, however, show that this overlapping was ample for the experiment. The contact between the two plates was as good as can be looked for in actual practice. The 5.5-inch plate next the structure had its original backing of 3.5 inches of oak and 2½-inch skin plates, and was secured to the structure by three holding-in bolts. The 6-inch plate was secured against the 5½-inch plate by timbers and bolts passing through previous impacts and a vertical timber at the end where it overlapped the 5½-inch plate, thoroughly secured by bolts above and below. All the experts present agreed that the plates were well secured together.

The impact on the front or 6-inch plate was 4 feet 1½ inches from the bottom, 2 feet 5 inches from the left edge and 2 feet 8 inches from the nearest impact—that is, the impact was about the center of the superimposed portions of the plate. The angle of impact was normal. The projectile penetrated both plates, passed through about 15 inches of sand, and coming to the surface was thrown out to the right and found at a point 70 feet to the rear and 33 feet to the right of the point of impact. The point was broken off the projectile. The number of pieces found was five, the largest piece weighing 453.5 pounds; the total weight of pieces picked up, 459 pounds. The projectile was pronounced to be of fine quality.

Effect on Front Plate.—The projectile made a clean hole through the 6-inch plate, the diameter of the hole being 10⅜ inches. The interior surface was fused. The diameter of flaking was 14 inches; diameter of back bulge, 22 inches; the height of back bulge was 3 inches, ragged, and there was a front fringe of about 1 inch. A number of radial and circular cracks were developed about the point of impact. A small piece was broken out of the plate toward the nearest edge.

Effect on Rear Plate.—The projectile passed through the rear plate, making a cone-shaped hole 16 inches in diameter on the side nearest to gun, 13 inches in diameter on the side furthest from the gun. The plate was dished 2 inches. The back bulge was all broken away. A through crack went from the impact to the right edge of the plate and two concentric cracks about half way around on the left side of the hole 24 to 32 inches in diameter. The backing and skin plates were badly torn by fragments of plate.

The tests were made under the direction of Lieutenant-Commander Couden, who made the following brief report of the result to the Department: "Although a comparison is difficult to make, it would seem that

this combined plate was somewhat less resistant than a single plate of the same thickness. Both these plates are of most excellent quality. The 6-inch plate has received 20 impacts and demonstrated its high resisting power and excellent quality heretofore. The rear plate has shown its quality on this occasion."

All experts who witnessed the test unite in the opinion that the superimposed plates proved much less efficient than single plates of their combined thickness, made under similar conditions and heretofore tested under equivalent specifications.

A test was made at Bethlehem during the past week of the 10-inch face-hardened armor of the battle-ships Kentucky and Kearsarge. These plates are nickel steel, double forged, and the ballistic plate was backed by 12 inches of oak and 2½-inch skin plates. Three rounds were fired, with the following results:

First Round.—Eight-inch armor-piercing shell; striking velocity, 1476 foot seconds. Plate uncracked; projectile broke up, head remaining sticking in plate; estimated penetration, 2 inches.

Second Round.—Eight-inch Holtzer armor-piercing shell; striking velocity, 1752 foot seconds. Plate uncracked; projectile broke up, head remaining sticking in plate; estimated penetration, 3 inches.

Third Round (supplemental).—Eight-inch Holtzer armor-piercing shell; striking velocity, 2078 foot seconds. Plate uncracked; projectile broke up, head remaining sticking in plate; penetration unknown.

While the tests at Indian Head of the two thin plates can hardly be compared with those at Bethlehem of the 10-inch plate, yet in whatever relation exists between the two the superiority of the thick plate is claimed by experts to be clearly apparent.—*Iron Age.*

At the Indian Head Proving Grounds a charge of 300 pounds of gun-cotton was recently exploded between two ⅝-inch iron plates, which were parallel and fifty feet apart; one was 15 and the other 35 feet from the explosive. It was expected that the detonation would injure the plates, but it did not. A great hole, however, was blown into the ground. It seems to be settled that high explosives must be nearer than 15 feet to injure a ship.

Experiment with Gathmann Shell.

Experiments which the Bureau of Ordnance of the Navy have been making at the Indian Head Proving Grounds with a shell intended to permit the use of high explosives in ordinary guns came to a somewhat disastrous end on Wednesday, June 1, by the bursting of the shell in the gun, which in turn was torn to pieces with a tremendous explosion. The witnesses of the trial escaped unharmed, though pieces of the burst gun and shell fell around the tug upon which the ordnance officers were watching the test. The officer who discharged the gun escaped only because he had sheltered himself behind an embankment instead of resorting to the usual corner of the bomb-proof, where the force of the explosion was so great that it collapsed a small wooden building used to shelter the instruments. The shell was a Gathmann shell, loaded with over 300 pounds of gun-cotton, and it is supposed that it was made to withstand the shock of the explosion of the powder charge in the gun, which in this case was much less than usual, the pressure being about three tons instead of 15 tons to the square inch. The gun destroyed was

jacketed tube, intended for a 13-inch gun, but so far only bored out as a 12-inch tube. The ordnance officers have never been satisfied as to the possibility of using gun-cotton in this way, but made the experiment by direction of Congress, which set aside an appropriation for the purpose.

Test of Jovite in Projectiles, and of Corn Pith in Cofferdams.

Important information in regard to three features of naval ordnance and construction was obtained to-day, June 12, as a result of tests made at the Indian Head Proving Grounds.

In the first place the officials demonstrated that jovite, the new high explosive, when loaded in a service armor-piercing projectile, could be safely fired from a high power gun through Harveyized armor, and would explode in the rear of the target. For the first time since the adoption of semi-armor piercing shells in the navy, one of 10 inches in caliber was fired through a Harveyized plate, the thickness of which was slightly greater than half the shell's caliber, and exploded in the rear. In addition, the trials to-day showed the ability of corn pith when placed back of armor to keep out the water, provided the armor and structure behind it are not greatly overmatched by the penetrating projectile.

The tests were made as the result of a recommendation by Chief Naval Constructor Hichborn that two cofferdams, one protected by 4-inch armor and the other by 5½-inch armor, be tested in order to ascertain whether or not corn pith could be depended upon to prevent water from entering a ship through a shot hole.

The cofferdam protected by 4-inch armor was first fired at with a 6-inch capped armor-piercing projectile with a velocity of 1800 feet per second. It made a clean hole in the armor, perforated the entire structure and the butt ten feet in the rear, and was picked up seventy feet away in excellent condition. The size of the hole in the rear of the cofferdam was about ten inches, through which very little water escaped.

Then a six-inch armor-piercing projectile, containing jovite and fused, was fired at the target with a velocity of 1865 feet per second. It was desired by the authorities that the shell should explode in the cofferdam. The shell failed to do as anticipated, but perforated the target and exploded fifteen feet from the face of the target. This is the first time an armor-piercing projectile has been safely exploded, powder failing to take such action.

The men on duty at the proving grounds hunted for some of the pieces of the projectile, but were unsuccessful. This showed that the projectile had been blown into small pieces, and had it exploded on shipboard the result would have been disastrous. No cracks appeared in the armor.

After these two shots were fired a box-like arrangement fitted in front of the four-inch plate was closed and water poured in. It was found that the water leaked from the shot holes in the rear of the target at the rate of about sixteen gallons per minute.

Attention was then directed to the target protected by five and a half inch armor. A 10-inch semi-armor-piercing shell was loaded with eighteen pounds of black powder and fired at the target with a velocity of 1650 feet per second. The shell perforated the target, practically demolishing the rear of the cofferdam and exploded just on the edge of the butt. The hole in the rear of the cofferdam was about four feet in diameter. —*New York Herald.*

[ENGLAND.]

TRIAL OF VICKERS SIX-INCH ARMOR PLATE.

We have succeeded in obtaining the following authentic details of the remarkably successful trial of the Vickers plate tested on board the Nettle at Portsmouth on the 19th of March last. The dimensions of the plate were 8 feet by 6 feet by 6 inches. It contained among other elements, 4 per cent. of nickel. There was originally a hair line about the center of the plate. The mounting and backing were as usual, the thickness at the top and bottom was 4 feet 10 inches, and at the center 5 feet 10 inches. The plate was secured by eight bolts.

The attack was made entirely with 6-inch Holtzer armor-piercing steel projectiles, fired with a charge of 48 pounds of EXE powder, which gave a muzzle velocity of about 1960 foot seconds. The striking velocity was practically the same, the plate being fixed at only a few feet along the deck.

The first shot was delivered near the right-hand bottom corner. The projectile broke up, leaving the point embedded, and apparently fused into the plate. When the point was jarred out by the 6th shot the depth of indent was found to be 2¼ inches. There was slight scaling round the point of impact. At the back was a bulge 1⅜ inch high, and 12 inches by 12 inches in area, with one crack. There may be noticed on the face certain white radiating splashes. These always seem to indicate complete disintegration of the shot. In former days they furnished evidence that the attacking projectile had been of chilled iron; but latterly, since the faces of plates have been specially hardened, steel projectiles have sometimes broken up in such a way as to exhibit these splashes.

The second round was delivered near the left-hand bottom corner. The result closely resembled that of the first round. Apparently, judging from the front, a larger part of the shot's point was embedded. There is more scaling, but no splash. The shot, however, seems to have flattened more, the bulge at the back being only ¾ inch in height, and having no crack in it.

The third round struck towards the left top corner, the shot breaking up in much the same way as before. There was a little more scaling off of the surface, and a hair crack was developed from point 2 to the left of the plate. After the point of this shot jarred out, the depth of the injury was found to be 1¾ inches. The bulge at the back was 1 inch high and 13 inches by 13 inches across.

Round 4 struck the near right top corner. The general result was as before; the shot spread as much as 2, but more of the mass lodged probably, as the bulge at the back was 1⅛ inch high and 14 inches by 14 inches across. There was rather more scaling round the shot, and the hair crack from 2 was rather more developed.

Round 5 was delivered near the center. The effect was again much as before, the shot breaking up in the same way. It was after this round that the point of No. 3 was dislodged, leaving the rest of the lodged portion of the head in a ring round it. The bulge at the back was 1 inch high, and both its horizontal and vertical cross measurements 14 inches.

This completed the proof test, which had been most successful in all respects. At the request of Messrs. Vickers a sixth shot was planted in the plate between rounds 5, 2, and 1, that is, a little below the center. The same general effects were again produced, though they were rather

greater, the surface of the plate was "driven in locally," and local cracking produced with irregular scaling about 2 inches deep, forming a sort of crater between rounds 2 and 6. The point of No. 1 was jarred out by this shot. The bulge at the back was 1½ inches high, and measured across 13 inches and 14 inches, and there was a crack made. Altogether, the slightly increased effect of this round only shows what we well know, that the molecular action in the metal of the plate extends further than could be seen from inspection.

As to ballistic results, the velocity is not measured, but is approximately 1960. This implies a striking energy of about 2665 foot tons, and a perforation by Tresidder's formula of about 13.45 inches of iron, or 2.24 times the thickness of the actual plate. Supposing the plate to weigh 5.275 tons, which is what we calculate from its dimensions, the energy per ton of each blow is 505 foot tons, and the total of the six blows 3030 foot tons per ton. This shows a more severe test than plates of this thickness have been hitherto subjected to. On these thin plates the shock of resisting strain never comes to a large amount, on account of their area being large in proportion to their thickness, but, as pointed out in the case of the Cammell and Brown plates similarly tried, the perforation attack defeated, works out very high. We wish, however, in order to enable a complete comparison to be made with foreign plates, one or more Wheeler-Sterling projectiles could be fired in our Nettle tests. As they are now supplied by Elswick, this might be easily done. We would conclude by congratulating first Messrs. Vickers, and then not only our three Sheffield makers, but England as a nation, on the excellence of the 6-inch plates now being delivered. This Vickers plate we are specially glad to describe, because it had an extra round fired at it, and is a singularly excellent plate.—*The Engineer.*

SHIPS OF WAR.

[United States.]

Trial of U. S. S. Iowa.

The U. S. battle-ship Iowa, constructed by the Messrs. Cramps, at Philadelphia, was given her official trial in Long Island Sound over the Cape Ann course on April 6, the weather conditions being most favorable. The stations were 6.6 miles apart, and the course was thirty-three miles north-northeast from the first station, about five miles southeast of Thatcher's Island to the sixth station, about a mile to the eastward of Boone Island buoy and return. The elapsed time for the first half was 1:57:23. Average speed, 16.873 knots; for second half, 1:55:24; average speed, 17.27. Average speed for the entire distance, 17 knots; elapsed time, 3:52:47.

The official speed as subsequently reported by the trial board, with all allowances for tides and other interfering conditions, was 17.871 knots.

The boilers showed an average pressure of 152 pounds, all that could be expected with the inch of air pressure allowed in the closed fire-rooms. Both engines ran with remarkable uniformity, the revolutions of the screws not falling below 111 per minute nor rising above 113½, and averaging 112 for the run.

The speed was also remarkably uniform between the several marks along the course, and shows that the vessel scarcely made any spurts, but kept close to her best work all the time, the variations being almost wholly due to the changing depth of the water.

After the trial her turning powers were tried. She answered her helm readily, and showed the possibility of turning a circle of less than 400 yards. She was also very steady in trimming, and her greatest angle of heel was only two degrees. The absence of vibration, even when the ship was driven at her highest speed, was very marked. In fact, the vibration could hardly be felt except at the extreme bow and stern.

Holland Submarine Boat.

The Holland submarine torpedo-boat was launched successfully from the yards of Mr. Lewis Nixon, at Elizabethport, N. J., on May 17.

The boat was towed into the adjoining slip, where she will remain until her private trial trip, after which she will be sent to Washington.

The date of her private trial trip has not been made public. An official public test will be made soon, Mr. Holland said, when an engineer officer from each government will be allowed on board. Mr. Holland, speaking of his boat just launched, was quoted as follows:

"The craft is 53 feet 3 inches long, with a diameter of 10 feet 3 inches amidships, a 4-foot screw protecting extension, and the moulded diameter is 10 feet 3 inches. She can travel under water 8 hours at 8 knots, and 10 knots on the surface. It will take barely one minute to submerge the boat, and not much longer to raise it to the surface of the water.

"The armament consists of three torpedo-tubes, one at the upper bow of the boat being an aerial torpedo thrower, with a range of one mile. Six projectiles weighing 180 pounds, with charges of 100 pounds of explosives, are to be stored for this gun.

"Almost directly beneath the torpedo-thrower is an expulsion tube for Whitehead torpedoes. Only three of these torpedoes will be carried, as each one weighs 850 pounds. At the stern of the boat is a submarine gun which, with a 100-pound charge of explosive, can hurl a 400-pound projectile 100 yards or more under the water. Five of these projectiles will be carried. The craft will be worked by six men.

"Now, I have this boat and one somewhat similar, which is being built at Baltimore. The latter boat is much longer than this one, and for that one reason more interest is centered in it."

TRIAL TRIPS OF GUNBOATS.

The Wilmington and Helena.

The gunboat Wilmington, built by the Newport News Shipbuilding & Dry Dock Company, made a very successful trial trip on March 27. The course was in Long Island Sound, from Horton's Point to Cornfield lightship and return, a distance of twice 27 knots. She drew 8 feet 2 inches forward and 9 feet 1 inch aft. The engines made a mean of 267 revolutions per minute; the maximum was 277. Steam pressure was 189 pounds. The contract speed was to be 13 knots, but she made 15.07 knots, earning a bonus of $41,512.

The Helena eclipsed the performance of the Wilmington, making the official speed of 15.49 knots per hour. She carried 180 pounds of steam and her engines made an average of 279 revolutions on the official run.

The Annapolis.

The new gunboat Annapolis, which is the first to be completed of the six composite hull boats ordered by the Government early in 1896, was given its official trial of four hours at full speed on Long Island Sound on April 22. This gunboat is notable as being the first U. S. Government vessel of large size to be fitted with boilers of the water-tube type exclusively. Other vessels have been built within a few years in which the Scotch type and the water-tube boilers have both been used in connection with each other.

The Annapolis was built at the Crescent Ship Yard, Louis Nixon, Manager, Elizabethport, N. J., and the boilers were furnished by the Babcock & Wilcox Co. of New York City, whose works are also at Elizabethport. The same type of boiler has also been adopted for the gunboat Marietta.

In this boiler the water tubes are all straight, placed at an angle of 15° with the horizontal, and expanded at each end into forged steel headers. Openings are provided in these headers opposite the ends of the tubes, through which a thorough examination of each tube may be made, and the tubes cleaned and renewed when necessary. By means of a steam jet inserted between the headers all deposits of soot may be removed from the exterior of the tubes. Surmounting the sections of tubes is a steam and water drum 42 inches diameter and 10 feet long; all openings leading into and out of drum are 4 inches diameter. Steam to 200 pounds pressure can be raised from cold water in half an hour, this being a most important feature in boilers for a war-ship. The boilers are designed for a working pressure of 250 pounds.

The principal dimensions of the Annapolis and of its steam equipment are as follows:

Length, 204 feet; width, 36 feet; depth, 23 feet 3½ inches; displacement on a draft of 12 feet, 1000 tons; boilers, two, each 94 square feet of grate and 3600 square feet of heating surface; ratio of grate to heating surface, 1 to 38.3; engine, triple expansion, with cylinders 15, 24½ and 40 inches diameter, 28 inches stroke; contract speed of vessel, 12 knots with 800 IHP. The builder's trial showed that 900 IHP could be developed under natural draft, with a short funnel.

On the official trial forced draft in the ash pit was used, each boiler being supplied by air from independent Sturtevant fans, the average air pressure in the ash pit being limited to 1 inch of water.

During the 4-hour trial the steam pressure averaged 226 pounds per square inch, the minimum being 218 and the maximum 240 pounds. The draft pressure in the ash pit averaged 0.90 inch on the port side and 0.91 inch on the starboard side. The speed trial over a measured course of 48 knots, marked by nine stake boats, gave a speed in the eight divisions of the course ranging from 12.7 to 14.18 knots per hour, averaging 13.43 knots.

The maximum IHP developed by the main engine was 1400, the average being 1320, at 147 revolutions per minute. The collective IHP will average about 1360. Dividing 1320 IHP into 3600 square feet heating surface gives one IHP for each 2.73 sq. ft. of heating surface. Dividing it by 94 square feet of grate gives 14 IHP per square feet of grate. During the test under forced draft the smokestack did not become hot enough to burn the paint off it.

At the end of the test of four hours at full speed the helm was put hard to port and to starboard without reducing speed, and the little vessel made circles with a diameter of 400 feet. In turning she heeled only 3.5 degrees.

The Nashville.

The new light-draft United States gunboat Nashville made her official trial on Long Island Sound on May 4, and earned for her builders, the Newport News Shipbuilding and Dry Dock Company, a bonus of near $60,000, her speed greatly exceeding that which was guaranteed, and for which the Government will reward her constructors. Her average speed throughout her trip was 16.7 knots, while but 14 knots was required. The course was laid from Stratford Light to Horton's Point, a distance of 30 miles in a straight line, and return. There were six stake boats, consisting of the tugs Leyden and Narkeeta, the lighthouse tender Cactus, and the torpedo-boats Stiletto, Porter, and Ericsson, which were anchored at distances of five miles along the course. The total time consumed in the run was three hours and forty-seven minutes. After the speed test the gunboat was put through several tests to show her seaworthiness, all of which were successful.

The Nashville is schooner-rigged, and is interesting because of her peculiar machinery arrangements. She has twin screws and two sets of quadruple expansion engines. The cylinders of these are arranged in fore and aft lines, with the low pressures towards the bow. The purpose is to disconnect these big cylinders by a shaft coupling when the vessel is on ordinary cruises, making the engines triple expansion, and as thus arranged they can be worked with small consumption of coal at about eight knots speed. By coupling the low-pressure cylinders with the others the speed may be run up to fourteen knots, though at the expense of much more coal. At cruising speeds an economy closely approximate to that of careful merchant steamers is expected. Her smoke-pipes are very tall, reaching almost to the top of her masts.

Aside from these novel machinery arrangements, the features of the Nashville are as follows: Length, 220 feet; breadth, 38 feet 3 inches; displacement, 1371 tons; complement, 150 men; battery, four rapid-fire 4-inch rifles on the main deck, four of the same in armored sponsons on the gun deck, four 6-pounder Hotchkiss guns and a number of 1-pounder and Gatling guns.—*Seaboard.*

The Wheeling.

The official trial trip of the gunboat Wheeling took place on Saturday, May 29, on a twelve-mile course in San Francisco bay. She ran four hours at 231.4 revolutions a minute, with a steam pressure of 180 pounds, giving a speed of 12.75 knots per hour. Her working was entirely satisfactory, less coal per horse-power being required than by her sister ship, the Marietta, and the engine and fire-rooms were cooler.

The Vicksburg.

The gunboat Vicksburg, sister ship of the Newport, had her official trial trip on May 29 off Bath, Me., and developed a speed of 12.68 knots an hour, which is about four-tenths of a knot better than the Newport made over the same course.

Trial Trips of the Porter.

The torpedo-boat Porter withstood a very severe test June 10, with the Board of Inspection and Survey on board of her, running her final trial before acceptance by the Government. She started at six o'clock in the morning from the foot of East Twenty-sixth street and returned to the same wharf at half-past six o'clock in the evening, having steamed around Long Island in twelve and one-half hours. She averaged about twenty knots for the run and varied from fifteen to thirty knots speed in both rough and smooth water.

Probably no other torpedo-boat ever had such a severe test, and certainly the Porter came through it splendidly, for she clearly demonstrated that she could make much more speed than she was contracted to make. This trial, however, was not for speed, and the steam pressure was limited to 200 pounds, instead of the 225 pounds that her boilers may carry.

She also demonstrated that her water-tube boilers can steam with salt water in them, though it was thought not advisable to carry more than one hundred pounds of steam under these circumstances.

Following are the particulars of her run: At six o'clock she left the wharf under one boiler, making fifteen knots up the East river, under the auxiliary stop valves. The Porter has two sets of stop valves, the main valve being a twelve-inch and the auxiliary stop being one and a half inches in diameter. At forty-four minutes past six she connected a second boiler, and for a time made twenty knots with 160 pounds of steam and one-quarter of an inch of air pressure forced draught.

At ten minutes past eight she opened the main stops and made twenty-five knots, with one inch of air pressure and 150 pounds of steam.

At half-past nine she connected the third boiler, and for fifty minutes, between Stratford Shoal and Falkner's, made thirty knots, with 200 pounds of steam and one inch of air pressure.

At the end of another fifty minutes, being out of sight of suitable ranges to get the actual speed for an hour, one boiler was cut out, and the Porter proceeded through Plum Gut and around Montauk Point at twenty-one knots, heading for Sandy Hook Lightship at half-past eleven, with Montauk light abeam.

A stiff breeze was blowing, with quite a heavy sea and white-caps.

To Fire Island she averaged eighteen knots, when a leak was developed in the main feed pipe which could not be controlled, so that all the fresh water was lost, and the vessel was obliged to drop to one boiler and use salt water therein, in addition to the evaporators and distillers.

The leak having been repaired, the Porter left the navy yard at seven o'clock, June 11, to complete the final trial for acceptance. She first went over to Communipaw for a small supply of coal, and at nine o'clock went alongside the dock at East Twenty-sixth street, where the Board of Inspection and Survey boarded her. She then steamed down to the lower bay, where the tests took place. These tests were eminently satisfactory.

All the torpedo-tubes were tested, torpedoes being successfully fired from each of the three tubes at a boat sent out from the Porter as a target. The turning circle of the Porter was determined with both engines going ahead at full speed, making seventeen knots, with the helm hard over. The diameter of her circle under these conditions was found to be about 1000 feet, a very small area for such speed.

Then the little boat squared away, and while going ahead at seventeen knots the engines were suddenly reversed. She stopped almost instantly, and was going full speed astern before she had gone one-half her length. Then the experiment was reversed, and the result astonished even those who have served in her since her commission. The little craft shook herself, stopped, and went ahead in less than one-quarter of her own length.

The time necessary to shift the helm by steam, from hard a-port to hard a-starboard, and the reverse, while going ahead at full speed, was found to be six seconds, and the same time is required for the return to hard a-port.

It was noted with curiosity that the Porter heels toward the center of her turning circle when the helm is put over. Other steam craft heel the other way under similar conditions. The hand-steering gear was tested from both forward and aft and found to be most satisfactory.

During the entire run of the day only one boiler was in use, and that one was the boiler in which salt water had been used during the Porter's run around Long Island on Thursday. This boiler worked well, and a careful examination shows no bad effects resulting from the use of the salt water.—*New York Herald.*

[CHILI.]

THE O'HIGGINS.

The Chilian cruiser O'Higgins was launched from the yard of Sir W. G. Armstrong, Whitworth & Co., Elswick, on May 17. The vessel is named after an Irishman who was the founder of the Chilian Navy, and ex-President Admiral Montt spoke of him also as the founder of the republic. The principal dimensions of the cruiser are: Length, 412 feet; breadth, 62 feet 9 inches; mean draft, 22 feet; displacement, 8500 tons. Her armament will consist of four 8-inch, ten 6-inch, four 4.7-inch, ten 12-pounders, ten 6-pounder quick-firing guns, four machine-guns, and three torpedo-tubes. The total coal capacity is 1200 tons, and the guaranteed speed is 21¼ knots.—*United Service Gazette.*

[ENGLAND.]

THE EUROPA.

H. M. S. Europa was launched March 20 at the Clydebank Shipbuilding Company's works. She is a first-class cruiser of the Diadem class, of 11,000 tons displacement, 435 feet length, 69 feet beam, and 25 feet 3 inches mean draft. Two sets of triple-expansion engines to develop 12,500 I. H. P. at natural draft, 16,500 with forced draft, giving a maximum speed of 21 knots. Coal capacity 1000 tons at normal draft; total capacity, 2000 tons. These vessels carry batteries of sixteen 6-inch and fourteen 12-pdr. R. F. guns, besides 12 3-pdrs. and numerous machine-guns. There are four funnels and two military masts.

THE PYRAMUS.

H. M. third-class cruiser Pyramus, of Pelorus type, was successfully floated out of the Jarrow dock on May 15.

Launches and Trial Trips of Destroyers.

The destroyer Chamois, on May 7, during her full speed preliminary run, maintained for three hours a mean speed of 30.336 knots with 386 revolutions per minute.

The Whiting, on her official trial, May 10, maintained for three hours a mean speed of 30.167 knots with 392.7 revolutions per minute. At the latter portion of the trial, when the tide was stronger and the boat had become somewhat lighter, a speed of 32.8 knots was attained.

The Earnest, on her official trial, May 24, maintain for three hours a mean speed of 30.12 knots.

The Griffon, on her three hours' coal consumption trial on May 25, maintained 30.02 knots. On her full-power trials, June 1, six runs over the measured mile resulted in a mean speed of 30.12 knots.

The Flirt was launched at Jarrow, May 22, and the Wolf at Birkenhead, June 2.

The Turbinia.

A further series of trials of the torpedo-boat Turbinia began on April 9th by Professor Ewing, F. R. S., and concluded on Wednesday, April 14th. The full speed trials were taken on Saturday, when the mean speed of 32¾ knots on the measured mile was realized. On several of the days the sea was rough, but throughout there was no perceptible racing of the screws, and the engines worked with perfect smoothness and a complete absence of vibration. On Wednesday the 14th the turning and circling tests were satisfactorily carried out, and a test for acceleration showed that the boat could be started from rest to 28½ knots speed in 20 seconds and brought to rest from this speed in 35 seconds.—*Engineering.*

[France.]

The Jena.

The dockyard authorities at Brest have received orders to proceed with the construction of the new battle-ship, designated in the estimates as A3, which is to be called the Jena. She will be laid down on the slip from which the Gaulois was launched last autumn, and will be the largest ship yet built at this yard. She will be somewhat larger than the Gaulois and her sisters, the Charlemagne and St. Louis, as the following comparison between the dimensions of the ships will show:

	Jena.	Gaulois.
Length	396 feet 9 inches.	385 feet 6 inches.
Beam	67 feet 3 inches.	66 feet 6 inches.
Maximum draft	27 feet 6 inches.	27 feet 6 inches.
Displacement	12,052 tons.	11,275 tons.
Speed	18 knots.	18 knots.
Maximum I. H. P.	15,500.	14,500
Normal coal storage	820 tons.	677 tons.
Radius of action at 10 knots	5200 miles.	4500 miles.

The ship will have three screws, steam being provided by twenty Belleville boilers, which will be fitted to burn either coal or petroleum. If necessary, the ship will be able to carry 1100 tons of coal, which will give her an extra radius of action of 1800 miles, or 7000 miles in all. Protection will be afforded by a complete water-line armor belt, with light

armor over the other works, and two armored decks, but the thickness of the armor has not yet been settled. The armament will consist of four 30.5-centimeter (12-inch) guns, in two turrets, one forward and one aft; in a central battery between the turrets will be eight 16-centimeter (6.3-inch) Q. F. guns, four firing from the beam to right ahead, and the other four from right astern to abeam; above, on the superstructure, will be eight 10-centimeter (3.9-inch) Q. F. guns similarly disposed for the end-on to beam fire; there will also be sixteen 3-pounder, five 1.5-pounder Q. F. guns, and thirteen 1-inch magazine guns, with six torpedo-tubes.

Lavoisier.

The third-class cruiser Lavoisier was launched at Rochefort on 18th April; her dimensions are as follows: Length, 326 feet 8 inches; beam, 35 feet 8 inches, with a displacement of 2300 tons. Her engines are to develop 6600 I. H. P., and her estimated speed will be 20 knots. Her armament is to consist of four 14-centimeter (5.5-inch), six 10-centimeter (3.9-inch), eight 3-pounder, and six 1-pounder guns, all Q. F., with four torpedo-tubes.—*Journal of Royal United Service Institution.*

[Germany.]

The Victoria Luise and the Hertha.

The second-class cruiser L was launched March 29 at the works of the Weser Company, and was christened Victoria Luise. The sister ship, K, christened Hertha, was launched April 14 at the Vulcan dock-yard, Stettin. The third vessel of this class, Ersatz Freya, is still on the ways.

These cruisers are built entirely of steel, 344 feet long, 57 feet extreme beam, with a mean draft of 20½ feet and a displacement of 5650 tons. They are driven by three screws, the three separate engines giving a total of 10,000 indicated horse-power, capable of producing a speed of 18½ knots. The coal capacity is 500 tons at normal draft. The armament will consist of two 8.2-inch Q. F. guns, one forward and one aft in 4-inch armored hooded barbettes, eight 6-inch Q. F. guns, four on the main deck in 4-inch armored casemates, two with an arc of training from right ahead to 35° abaft the beam, and two with an arc of training from right astern to 35° before the beam, and the other four on the upper deck. Also in armored casemates ten 3.4-inch Q. F. guns (20-pounders), ten 3-pounder Q. F. guns, and four machine-guns with three submerged torpedo-tubes, one in the stern and one on each beam. There is a 4-inch armored deck, and the heavier guns have separate armored ammunition tubes, all the armor being of Krupp's nickel-hardened steel. The total complement will be 439 officers and men.

Station Cruiser G.

The new station cruiser G is to be built at the Germania yard at Kiel, which was lately taken over by the Krupp firm at Essen. Like the earlier fourth-class cruisers, the new vessel is intended for foreign service, but it is is of an improved type, her dimensions being as follows: Length, 325 feet; beam, 36 feet; mean draft, 14 feet, with a displacement of about 2600 tons. The hull will be of steel, wood sheathed; there will be a two-inch armored deck and an armored conning tower. The

engines are to develop 6000 I. H. P., giving a speed of 20 knots. It is proposed to lay down four vessels of this type as soon as the money can be voted for them.

[Italy.]

St. Bon.

The battle-ship St. Bon, named after Admiral St. Bon, was successfully launched on May 29th. She is a sister ship of the Emanuele Filiberto and was built at the Royal Dockyard at Venice. Her principal dimensions are as follows: Length, 345 feet; breadth, 70 feet; mean draft, 24 feet 9 inches; displacement, 9800 tons. The two sets of vertical triple expansion engines were built by the Ansaldo firm, and with 13,500 indicated horse-power will give a speed of 18 knots. There are 12 cylindric boilers with 36 furnaces. The total coal capacity is 1000 tons, given a steaming radius of 7500 miles at 10 knots; besides this, liquid fuel can be carried in the double bottoms. There is a complete armor belt along the waterline of Terni nickel steel plates varying in thickness from 4 to 9.8 inches, the armor of the redoubt and barbettes 9.8 inches; the battery is protected by 5.9 inches. The armament consists of four 10-inch breech-loading rifles, two in the forward barbette and two aft, eight 6-inch R. F. guns in the redoubt, each gun being further protected by steel splinter bulkheads, eight 4.7-inch R. F. guns, also six 57 mm. guns, as well as numerous rapid-fire guns of smaller caliber. All these guns were built at the Armstrong establishment at Pozzuoli and at the Spezia arsenal. There are one stem and four broadside torpedo-tubes. The complement will be six hundred men and officers. In launching this ship the custom of breaking a bottle of wine over the bows was departed from. The Crown Princess Helen followed an old Venetian custom, securing to the ship a gilded bronze ring about 5½ inches diameter, engraved with a suitable inscription, by means of a silk ribbon of such a length that during the launching this ring would touch the water first. The ring will be preserved in the Royal Arsenal.

Auxiliary Cruisers.

The following-named vessels are destined as auxiliary cruisers in case of war: The Nord America, length, 445 feet; displacement, 4826 tons; Vittoria, length, 400 feet; 4300 tons; 4500 indicated horse-power; Duca di Galliera and Duchessa di Genova of the Veloce Company; the Regina Margherita, length, 375 feet, 4000 tons, 3687 indicated horse-power; Elettrico, Candia and Malta, all of the Company Navigozione générale. The vessels are each to be armed with light rapid-fire batteries.

[Japan.]

Trials of the Fuji.

The battle-ship Fuji, built at the Thames Ironworks, on her first trials of six hours' steaming, averaged 16.937 knots with 10,200 indicated horse-power. The later trials for full speed gave a mean speed of 18.655 knots with 14,100 horse-power, the vessel being down to her deep-load draft. The steering gear, supplied by Davis & Co., enabled the helm to be put from hard-over to hard-over in 16 seconds.

The Latest Japanese Battle-ship.

Within the past two months the Thames Ironworks and Shipbuilding Company have contracted to build for the Imperial Japanese Government a still larger and more powerful battle-ship than the Fuji, a vessel, in fact, which in her offensive and defensive powers will constitute one of the most formidable armor-clads yet constructed for any navy.

As the displacement of the largest armor-clads of the British Navy—those of the Majestic class—when fully equipped, but without their coal—900 tons—on board is only 14,000 tons, the new Japanese vessel, which is to have a displacement of 14,850 tons, with a coal capacity of 700, will have 150 tons more weight in her hull than any of the battle-ships of the class mentioned.

The dimensions of the new vessel are to be: Length between perpendiculars, 400 feet; over all, 438 feet; breadth, 75 feet 6 inches; water draft, 27 feet 3 inches, and displacement as given above, viz., 14,850 tons. She will be constructed on the double-bottomed system, with water-tight flats at her ends, practically making her double-bottomed throughout. Her side protection will consist of a lower armor belt, made of Harveyed nickel steel, carried from stem to stern, 8 feet 2 inches deep, and 9 inches thick throughout the length of the engine, boiler and magazine spaces, tapering to 4 inches at the ends. Above the lower armor belt, and for a length of 250 feet amidships—which length encloses the two barbettes for the big guns—an additional belt of 6-inch armor is to be worked to the height of the main deck. Rising from the lower edge of the main armor belt to a height on the middle line of the ship of about 3 feet above the water-line, and extending from stem to stern, there will be a complete armor deck of steel 3 inches thick on the flat part and 5 inches on the slopes, tapering at the ends. From this deck, and at either end of the 250 feet armor belt, which forms the sides of and is equal to the length of the citadel, the two barbettes, which are to be circular in form and protected by 14-inch armor, rise through the main deck, and continue to a height of 4 feet above the upper deck. A curved thwartships bulkhead of steel 14 inches thick will be worked from above the protective deck to the height of the main deck, and between the main and upper decks steel screen bulkheads will also be fitted, extending from the barbettes to the ship's sides.

The armament of the new battle-ship will consist of four 12-inch 40-caliber breech-loading guns, two being in the forward and two in the after barbette; fourteen 6-inch 40-caliber quick-firing guns in armored casemates of 6-inch Harveyed nickel steel, eight being on the main deck and six on the upper deck, the casemates being made water-tight on their inner and outer sides, thus serving to protect the gun crews from explosive shells entering between decks, and preventing water finding its way there should a gun port become damaged. Supplementing the above detailed armament there are to be twenty 12-pounder quick-firing guns placed on the upper deck, eight 47-millimeter guns on the upper and main decks and military tops, and four similar sized guns on the bridges. There will also be fitted five 18-inch torpedo ejectors, one in the stem above water and four submerged, the usual torpedo-nets completing the defensive gear.

The steering of the vessel will be effected by steering gear, on Cameron's self-regulating principle, worked by steam-steering engines in duplicate, as a preventive in case of the possible failure of one set, the

controlling gear being on Messrs. Brown's telemotor principle, controlling the helm from pilot house, forward bridge, after pilot house and bridge, and from the protective deck forward.

The propelling machinery of the new ship, which will be of 14,500 indicated horse-power, will consist of two complete sets—in separate engine-rooms—of three-cylinder triple-expansion twin-screw engines, the diameters of the cylinders being 34 inches, 53 inches, and 84 inches for high, intermediate, and low pressure respectively, with a piston stroke of 48 inches. They will be supplied with steam by twenty-five of the latest type of Belleville boilers, having an aggregate heating surface of 40,000 square feet.

The ship will be lighted throughout by electricity, the installation consisting of four sets of combined engines and dynamos—three of 400 ampères and 80 volts each and one of 200 ampères and 80 volts, the latter of the direct current type. Nine hundred incandescent lamps of 16-candle power each will be provided for lighting saloons and cabins, store, engine, and boiler-rooms, magazines and coal bunkers, etc. Six search-lights, each of 20,000 candle-power, having mirrors 24 inches in diameter, will also be provided.

The complement of boats carried by the new battle-ships will be fourteen, and will include two 50-feet vedette boats, fitted with the Thames Ironworks water-tube boilers; one 42-foot launch, and one 30-foot steam pinnace, each of which will carry Whitehead torpedoes, and be fitted for mining and countermining.

The ship will have a complement of men and officers to the number of 741, which will include an admiral and thirty-eight officers. The contract time for the completion of the vessel has been fixed at twenty-seven months.—*Engineer.*

The Japanese Government have entered into a contract with Messrs. Yarrow & Co., Limited, of Poplar, for the construction of four torpedo-boat destroyers of 31 knots speed.

[Norway.]

Tordenskjold.

From the Walker shipyard of Sir W. G. Armstrong, Whitworth & Co., there was launched on the 18th of March, for the Norwegian navy, the armor-clad ship Tordenskjold. The vessel is a sister ship of the Harald Harfaagre, which was launched on January 4 last from the same yard. There is an armor belt 7 inches to 4 inches in thickness; the conning tower is protected with 6-inch armor plate, and she has a ram. The armament, differing somewhat from that of her sister ship, will consist of two 8-inch quick-firing guns, six 4.7-inch quick-firing guns, six 12-pounder quick-firing guns, and six 1½-pounder quick-firing guns.

[Russia.]

Great activity continues to reign in all the Russian dockyards. At Nicolaieff, a second-class battle-ship, a sister ship to the Rotislav and Sissoi Velikie, of 8800 tons displacement, has been laid down. In addition, two first-class battle-ships of 12,480 tons are to be commenced, of which one is to be ready for launching next year, and the second in 1900.

The construction of the battle-ships Poltava, Petropavlovsk and Sevastopol, each of 10,960 tons, is rapidly approaching completion, and the armored coast-defense vessels Apraxin, of 4126 tons, and the gunboat Khrabry, of 1500 tons, will be shortly ready for sea.

At the New Admiralty Dockyard, St. Petersburg, the squadron battle-ship Osliaba, of 12,840 tons, 14,500 horse-power, and 15.5 knots; the first-class cruiser Aurora, of 6630 tons, 12,000 horse-power, and 21 knots, are nearly ready; the gunboat Gilyak, of 810 tons, and an armored coast-defense vessel of 4126 tons and 5250 horse-power, are building. At the Galierny Ostrov, the ocean cruisers Diana and Pallada, each of 6630 tons, 12,000 horse-power, and 21 knots. At the Baltic Works, the squadron battle-ship Pereswiet, of 12,480 tons, 14,500 horse-power; in France, the cruiser Svetlana, of 3828 tons, 9000 horse-power, and 20 knots. Besides the aforementioned vessels, there are also building in the Baltic two torpedo-cruisers to be named Abrek and X, and fifteen torpedo-boats.

The old armored battery Netronj-Menia is to receive new boilers and be fitted for petroleum fuel. Two new sea-going torpedo-boats, Nos. 133 and 134, have completed their trials off Cronstadt; they averaged a speed of 24.5 knots, and are fitted with Du Temple water-tube boilers. These boats are two out of ten constructed by the Moscow Company on the Neva; two other larger boats, 180 feet long, have been ordered at the Creighton Works at Abo. Further experiments with the Masut (a petroleum mixture) fuel have been carried out in the first-class torpedo-boat Viborg, and as a result all torpedo-boats fitted with locomotive boilers are to be fitted to consume this fuel. Torpedo-boats with water-tube boilers have not as yet been so fitted, but in all the new boats the necessary arrangements are to be made.

The new first-class battle-ship Tri Sviatitelia has undergone her twelve hours' full speed trial, which was completely successful. The engines worked smoothly throughout, developing considerably more than the contract horse-power, and gave the ship a speed of 18 knots instead of 16, for which the vessel was designed. The engines were built by Messrs. Humphrys, Tennant & Co., of Deptford, who have built the engines for so many of the Russian ships.

[Spain.]

Osada.

The Clydebank Engineering and Shipbuilding Company, Limited, on March 16 launched a twin-screw torpedo-boat destroyer named the Osado, constructed for the Spanish Government. The Clydebank Company some time ago received orders to build for the Spanish Government a number of vessels of this class, and recently they delivered the Furor and Terror, after they had gone through speed trials very satisfactorily. The vessel now launched will be similar to the Furor and Terror, and will carry the same armament, but the tonnage will be somewhat greater, and she is to steam two knots faster. While resembling in appearance the destroyers built at Clydebank for the British Government, these vessels have some necessary modifications in arrangements and fittings, principally with the view to making them suitable for service in very hot climates.—*Engineering.*

The New Cruiser Rio De La Plata.

The Spanish residents of Rio De La Plata have determined as a token of their loyalty to and love for their mother country to present the

Spanish Government with a ship-of-war. Her name is to be Rio De La Plata, and she is to be built at the Forges et Chantiers Works. She is to be a cruiser of 1750 tons displacement, to make a speed of 16½ knots natural draft and 21 knots with forced draft. The triple-expansion engines to develop 7100 horse-power, steam to be furnished by four Normand boilers. The coal capacity of 270 tons to give a steaming radius of four thousand sea miles at 12½ knots speed. The protective deck to have a thickness of .4 inch thick on top and .8 on the sides. The vessel is to have two masts with fighting tops, a steel conning tower, a sharp ram, to be provided with three search-lights and full electric lighting plant. The armament to consist of Hontoria guns, viz.: Two 6-inch, four 4.7-inch, six 57 mm. rapid-fire guns, besides two 37 mm. Hotchkiss revolving guns, four 25 mm. machine-guns and two fieldpieces. There will be two torpedo-tubes and six torpedoes.—*Diario de Cadiz.*

The Cristobal Colon.

This armored cruiser, of 6840 tons, built by Ansaldo firm of Genoa, had her trial trips on the 27th and 28th of April. With natural draft, and with 98 to 100 revolutions, she made an average speed of 19.56 knots per hour. During the sixth hour coal consumption trial, during which she made a speed of 18½ knots, the consumption of coal was 1.62 pounds per horse-power per hour.—*Le Yacht.*

Maxim Guns for the Navy.

The latest model of the seven mm. Maxim machine-gun is to be generally introduced into the Spanish Navy. The armored cruiser Carlos V is to be at once supplied with these guns.

[Sweden.]

A New Submarine Boat.

Engineer Nordenfeldt has built a new submarine torpedo-boat, the preliminary trial trips of which both at the surface and at a depth of 30 feet were begun a short time ago. The boat is cigar shape, has a length of 65 feet and a maximum diameter of nearly 12 feet. The motive power is steam, the diving apparatus is automatic. The crew will consist of three men. Trial trips of one hundred and fifty miles will be made between Stockholm and Gothenburg.—*Le Yacht.*

BOOK NOTICES AND REVIEWS.

MAHAN'S LIFE OF NELSON.

In view of the many excellent reviews of this latest work of Captain A. T. Mahan, U. S. Navy, which have appeared at home and abroad, the following one, taken at random, and which appeared in the *Spectator* of April 17, 1897, is republished:

"This is a book which is so great, great in so many ways, that as one closes it one almost fears to review, lest one should be tempted to use language that will rather mar the effect which its own charm and its own power ought to exercise on the independent mind of every reader. What we should like to do is simply to convince every one that they ought to read it for themselves, with no fears that they will not be able to understand every line of it, and that they should then freely form their own judgment upon it. That Captain Mahan is able to write of naval warfare in such style and with such clearness as to make it easily intelligible to every landsman, is well known to all those who have read his fascinating volumes on "The Influence of Sea Power on History." The capacity which he shows in this work for pure biography, for bringing out in all its light and shades one of the most striking characters in all history, has not been disclosed before. The "Life of Admiral Farragut" was a much simpler effort. Each of his works has shown a growing strength, both in its literary style and in the confidence with which he lays down principles, works out a solid basis of fact from conflicting evidence, and draws from his facts deductions of permanent value.

The moral problems with which he has to deal in this book are of wider human application than even those great political and statesmanlike questions which both in this and in his former works, have in his lucid exposition been handled in such a manner as to influence the decisions of kingdoms and empires, and materially to affect the relations of the Great Powers of Europe. As a biography of a great man of action it seems to us to have no rival. Captain Mahan's enthusiasm for Nelson the hero, the great sea-captain, the devoted self-sacrificing subject of the English crown, never leads him into doing injustice to those whom Nelson wronged, never for a moment makes him swerve from his clear perception of Nelson's violations of the moral law. That is much. But that which is far more striking is that he never for a moment assumes that tone of patronising superiority which, when the lapses of his hero occur, it is so hard to avoid without seeming to approve that which it would be most dangerous that he should not condemn. Whether in dealing with Nelson's treatment of his wife, with the execution of Caraccioli, with his relations to Sir William and Lady Hamilton, or with such relatively less important matters as his not infrequent acts of wilfulness, the soundness and healthiness of the tone of the biographer is a most marked characteristic. Much material has come into Captain Mahan's hands which was not available for Nelson's earlier biographers. This chiefly affects the delicate ques-

tion of his domestic relationships. Unhappily, its whole tendency is to make the case of Nelson's conduct in the matter of Sir William and Lady Hamilton look distinctly blacker than it had done before. Many of us had previously doubted whether Horatia, though she was most certainly Nelson's child, might not have been the daughter of some other woman than Lady Hamilton. Captain Mahan appears to have shown conclusively that the doubts on this point had been only due to an elaborate system of mystification devised by Nelson, not merely for the protection of Lady Hamilton's reputation, but in order to conceal the betrayal of Sir William under circumstances peculiarly disgraceful to him as a man, and contrary to all his own strongest sentiments of honor.

"However great was Nelson's infatuation," says Sir Harris Nicolas, "his nice sense of honor, his feelings of propriety, and his love of truth were unquestionable. Hence, though during a long separation from his wife on public service in the Mediterranean, he so far yielded to temptation as to become the father of a child, it is nevertheless difficult to believe that he should for years have had criminal intercourse with the wife of a man of his own rank, whom he considered as his dearest friend, who placed the greatest confidence in his honor and virtue, and in whose house he was living. Still more difficult is it to believe, even if this had been the case, that he should not only have permitted every one of his relations, male and female—his wife, his father, his brothers, his brothers-in-law, his two sisters and all their daughters—to visit and correspond with her; have ostentatiously and frequently written and spoken of her virtuous and religious character, holding her up as an example to his family; have appointed her the sole guardian of his child; have avowedly intended to make her his wife; have acted upon every occasion as if the purity of their intimacy was altogether free from suspicions; and in the last written act of his life have solemnly called upon his country to reward and support her. An honorable and conscientious man rarely acts thus toward his mistress. Moreover, Nelson's most intimate friends, including the Earl of St. Vincent, who called them a pair of 'sentimental fools,' Dr. Scott, his chaplain, and Mr. Haslewood were of the same opinion, and Southey says 'there is no reason to believe that this most unfortunate attachment was criminal.'"

That quotation from Nicolas sets forth fully the reasons why many of us had perhaps partly allowed the "wish to be father to the thought" that Horatia's mother might not have been Lady Hamilton. Alas! the evidence which Captain Mahan has produced appears to show conclusively that that hope and that wish were a dream. As he puts it—

"This complicated and difficult path of deception had to be trod, because the offence was not one of common error, readily pardoned if discovered, but because the man betrayed, whatever his faults otherwise, had shown both the culprits unbounded confidence and kindness, and upon the woman, at least, had been led by his love to confer a benefit which neither should have forgotten."

And yet with wonderful power Captain Mahan has made the life consistent with the character of a man singularly noble and generous, the most ready of all men to devote his whole life and all his energies to the service of his country, and has shown how the "breadth and acuteness of Nelson's intellect have been too much overlooked in the admiration excited by his unusually grand moral endowments of resolution, dash, and fearlessness of responsibility. . . . In this contrast, of the exaltation of the hero and the patriot with the degradation of the man, lie the tragedy and the misery of Nelson's story."

Nevertheless, taken as a whole, the life is an inspiring one, and its grander qualities can no more be obscured by the one great lapse than is the story of Bathsheba able to destroy the inspiration of David's genius and devotion. Only the strange part of the matter is that the very strength of Nelson's character and his self-confidence made him never feel a shadow of regret or repentance, so far as any outward indications appear, and did not in the least, so far as can be judged, affect that intense religious feeling and absolute sense of trust in the Most High with which he went into all the greater actions of his life, or even his daily dependence in ordinary concerns upon Almighty protection. On the whole, we think that in the matter of the execution of Caraccioli Captain Mahan has cleared Nelson from the graver stains which have been supposed to be attached to the act. He thinks, and we believe rightly, that Nelson was legitimately entitled, under the circumstances, to break the convention with the Neapolitan rebels, the convention having been made without his authority, and no advantage having been taken of it, before it was repudiated, to put them in a worse position than they had been in before it was made. The influence of Lady Hamilton does not appear to have been exerted in the matter. The great objection to his conduct in ordering the trial and prompt execution is that "it stands conspicuous as the act of an English officer imbued with the spirit of a Bourbon official." He was acting at the moment under the authority of the King of Naples in the latter capacity; but it was impossible that the world should distinguish between the British admiral and the Neapolitan King's vicegerent.

That Captain Mahan's volumes should be full of valuable suggestions in regard to many questions that are of importance at the present time, especially as to the bearing of the question of naval supremacy upon the possibilities of the invasion of England and of the best forms which her defense can assume, was to be fully expected from his previous record. He has, in fact, dealt with a fire and vigor which leave nothing to be desired, with a large number of questions which have been lately discussed. He is as firmly convinced as we that Napoleon did distinctly intend, at the time of the Boulogne camp, to carry out the invasion of England, and that he only desisted from the attempt because he had been baffled by the superior skill, seamanship, and audacity of the English sailors against his own admirals. Without going into details, which would be here impossible, we may say that the general effect of Captain Mahan's contention is very strongly to bring out the necessity of a defense by land as well as sea. Moreover, the art with which he has made most interesting those periods of Nelson's work, during which it was his patience, his resource, and the vitalizing energy with which he infected all under him that were conspicuous, rather than skill or daring in battle, is especially effective in this, that it brings out better than it has ever done before how all-important was the co-operation of sea and land forces for the full use of that power of which Nelson was the embodiment. Captain Mahan has an almost Shakesperian tendency to drop as he goes along wise reflections, pithy sentences, gnomoe, many of which are, apart from their context, of almost universal application in the affairs of life. Often they are highly polished, always wholesome, and not infrequently very weighty.

Altogether it is a great biography, and one to be read by all men, whether they know much or little of previous attempts at the portrayal of our greatest sailor and most patriotic Englishman."

Agricultural Research Service
U.S. Department of Agriculture

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MAY 1. Tribute to a Hero. Usefulness of Naval Militia.

MAY 8. The Torpedo-boat Porter. The Army: Its Employment in Time of Peace.

MAY 15. Russet Leather Horse Equipments. The Brooklyn Dry Docks.

MAY 22. Firing Regulations Revised. The Army; Its Employment in Time of Peace.

MAY 29. Army Small-Arms Firing Regulations. The Government is too Poor.

JUNE 5. The Army; Its Employment in Time of Peace. Army Firing Regulations.

JUNE 12. Marines at Ships' Guns. The Army; Its Employment in Time of Peace.

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

MAY, 1897. The Construction, Installation and Performance of the Electric Lighting Plant at the Government Hospital for the Insane at Washington, D. C. Contract Trial of the Gresham. Experiments with an Air-Lubricated Journal. The Design and Testing of Centrifugal Fans. On Crank Shafts. The Contract Trials of the U. S. Gunboats Helena and Wilmington. The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion.

JOURNAL OF THE ASSOCIATION OF ENGINEERING SOCIETIES.

APRIL, 1897. The Use of Electric Motors in Machine Shops. European Boiler Practice.

AMERICAN ELECTRICIAN.

APRIL, 1897. The Insulation of Armature Cores. Thermo-Electric Batteries. Interior Wiring. Fly-Wheel Governors. Calculation of Wiring.

MAY. Dynamo Characteristics. Electric Pumping Construction of a Galvanometer. Interior Wiring. Steam Engine Economics. Lessons in Practical Electricity.

JUNE. A Modern American Central Station. Central Station of Rouen, France. Central Station of Brighton, England. Multiple Expansion Engines and the Cost Account. Drop in Alternating Current Lines. The Economics of Power Transmission.

ELECTRICAL ENGINEERING.

JUNE 1, 1897. Some Notes on the Manufacture of Incandescent Lamps. Higher Mathematics.

THE UNITED SERVICE.

MARCH, 1897. The Siege of Hamburg. His Last Appearance. Depreciators of the Nation. The Yacht Gnome. Conversational Arithmetic. The Soldier's Leisure Hours in a Western Army Post.

APRIL. Washington as a Soldier. The Indian Mutiny in Fiction. The Yacht Gnome (continued). Conversational Arithmetic (continued).

JOURNAL OF THE U. S. CAVALRY ASSOCIATION.

MARCH, 1897. Work of the Cavalry in Protecting Yellowstone National Park. Horse-shoeing. The Shelter Tent. Campaigning in Arizona and New Mexico, 1895-6. Device for Loading and Unloading Cavalry Horses in Movements by Rail. Notes on Feeding Cavalry Horses.

ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

APRIL 15, 1897. Compressed Air for Blowing Fog Signals.

MAY 20. The Frames of the Friedrich (illustrated). Leaks in the Brooklyn Dry Docks.

THE ENGINEER.

APRIL 10, 1897. The Rotary Steam Engine. Corrosion and Scale from Feed Waters. Heating Feed Water by Exhaust Steam.

APRIL 24. Marine Propulsion in the Past. The Steam Turbine. Spontaneous Combustion of Coal.

MAY 22. Coaling War-ships at Sea. The Manufacture of Guns in the United States. Official Trials of the Helena and Wilmington.

JUNE 5. Experiment in Boiler Bracing.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

MAY, 1897. Proper Military Instruction. The Present Status of Field Artillery. Ammunition Supply in Foreign Armies. Proposed Uniform Examinations. A Sketching Board.

JOURNAL OF THE UNITED STATES ARTILLERY.

No. 25, MARCH-APRIL, 1897. Field Shrapnel and the Cannon of the Present. Some Notes on our Artillery Target Practice. An Improved Method of Hauling Heavy Guns. The Progressive Development of the Schools for Artillery Practice in Germany. An Experiment with Militia in Heavy Artillery Work. Report on Development of a Photo Retardograph.

THE IRON AGE.

APRIL 22, 1897. A Year's Shipwrecks. The Armor Question.

MAY 6. Profits on Armor Plate Manufacture. Armor Plate Negotiations.

MAY 20. Iron Fortifications (illustrated). A Recent Bethlehem Plate (illustrated). The Light House Establishment. Petroleum Fuel for Vessels.

MAY 27. The Manufacture of the Colt Navy Revolver, Model 1895.

SCIENTIFIC AMERICAN.

APRIL 10, 1897. First-class Battle-ship Iowa. Patents of Naval Officers.

APRIL 17. No Bids for Armor Plate. The Battle-ship Iowa.

MAY 1. Nickel Steel Armor. Large Shipment of Army Cannon.

MAY 8. Naval Parade, Grant Monument Dedication. The Fastest Vessel Afloat.

MAY 22. Brooklyn Navy Yard Dry Dock Leak. Inventor of the Automatic Gun. Gun Manufacture in the United States. Brooklyn Navy Yard Dry Dock Leak. Mast Arm Electric Lamp.

JUNE 5. Improved Rapid-fire Guns.

JUNE 19. Two New Atlantic Steamships. Great Steamships' Engines. Oiling Ships' Hulls. The Torpedo-boat Porter.

CASSIER'S MAGAZINE.

JUNE, 1897. Steam and Hydraulic Steering Gears. The Evolution of the British Coasting Steamer.

SEABOARD.

APRIL 1, 1897. Speed of Gunboats Wilmington and Helena. Description of Gunboats.

APRIL 8 and 15. Senator Elkins' Speech for Discriminating Duties. Bonus on the Iowa.

APRIL 22. Senator Elkins' Speech (continued). Official Report on the Trial of the New Gunboats.

APRIL 29. Senator Elkins' Speech (continued).

[FOREIGN.]

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

APRIL, 1897. The Relative Advantages of Voluntary and Compulsory Service, both from a Military and a National Point of View. Shorthand in the Army. Swiss Regiments à l'étranger. The Construction and Working of Belleville Boilers. The First Forcing of the Khaibar Pass, 1838-39. Naval and Military Notes.

MAY. The Relative Advantages and Disadvantages of Volun-

tary and Compulsory Service, both from a Military and a National Point of View. The National Study of Military History. Obok and the Country Bordering on the Gulf of Tajura.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

APRIL, 1897. The British Army in the Continent of Europe. Coast Defense.

MAY. The Science of Frontier Delimitation. Direct and Indirect Fire. Encampments in Hill Warfare on the N. W. Frontier of India.

ENGINEERING.

MARCH 26, 1897. The U. S. Battle-ship Alabama (illustrated). Manning the Navy. The Prevention of the Vibration in Steamships. The Stevens Battery (illustrated).

APRIL 2. New Battle-ship for the Japanese Navy (illustrated). The Growth of a Japanese Steamship Company. The Prevention of the Vibration of Steamships. Maxim's Testing Apparatus for Smokeless Powder (illustrated).

APRIL 9. Dry-Back Marine Boiler (illustrated). Ascertaining the Stability of Ships (illustrated). Apparatus for Measuring Stellar Photographs (illustrated). Water-tube Boilers in Warships.

APRIL 16. British Sailors and British Ships. Re-arming the Older Ironclads. The Steam Turbine and Marine Propulsion (illustrated). Designing Ship's Lines. The Accelerity Diagram of the Steam Engine (illustrated).

APRIL 23. The U. S. S. Terror and the Pneumatic System as Applied to the Guns, Turrets and Rudder (illustrated). The Hotchkiss Automatic Gun (illustrated). Automatic Machine Guns.

APRIL 30. Rapson's Slide as Applied to the Steering of Large Ships. Nickel Steel (illustrated).

MAY 7. Lyall's Water-tube Boiler (illustrated). The Accident to H. M. S. Star.

MAY 21. The Rocket.

JUNE 4. Petroleum as Steam Engine Fuel (illustrated). Rotary vs. Reciprocating Marine Engines (illustrated).

THE ENGINEER.

MARCH 26, 1897. Canal Communication from the Midlands to the Sea (illustrated). Some Great Liners. The New Japanese Battle-ships (illustrated). The Chilian Cruiser Esmeralda (illustrated).

April 2. Aluminum: Its Present and Future, No. 1. The Alabama and the Prince George (illustrated). Behr Lightning Express Railway Carriage. Hamburg-American Liners Pennsylvania and Arabia (illustrated). Marine Propulsion in the Past. The latest Japanese Battle-ship.

April 9. Water-tube Boilers in War-ships. The Steering Gear of the Japanese Battle-ship Fuji (illustrated). Recent Trials of the Cruisers Powerful and Terrible. Mechanical Method of Ascertaining Stability of Ships. British and Foreign Armor and Shot.

April 16. On the Fighting Value of Certain of the Older Ironclads if Re-armed. Sims-Dudley Powder-Pneumatic Gun (illustrated). Hotchkiss Automatic Machine Gun Trial. Navy Boilers. The Use of the Mean Water-Line in Designing the Line of Ships. The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion.

April 23. Aluminum: Its Present and Future, No. 2. Recent Developments in Mercantile Ship Construction. The Cruiser Brooklyn, United States Navy (illustrated). Woolwich Arsenal. H. M. S. Swordfish and Spitfire (illustrated).

April 30. Harvey Nickel Plate Trials (illustrated). Steam Pinnaces for the Admiralty. The French Submarine Cable-Laying and Repairing Steamer Portena (illustrated).

May 7. Recent Developments in Mercantile Ship Construction, No. 2. Army Signaling and its Use in War. A New Chronograph (illustrated). Submarine Telegraphy during War (illustrated). The Augusta Victoria (illustrated). Bigler's Signal Buoy (illustrated).

May 21. Aluminum: Its Present and Future, No. 3. The Steamship La Grande Duchesse (illustrated).

May 28. Aluminum: Its Present and Future, No. 4. Water-tube Boilers in the Mercantile Marine.

June 4. The Naval Section of the Victorian Exhibition, Crystal Palace. The Birkenhead Destroyers. The French Navy.

MORSKOI SBORNIK.

March, 1897. Discussion of Problems in Naval Tactics. Classification of Fighting Ships. Notes on Ordnance and Armor. Trial of the Machinery of the English Cruiser Terrible. The Dalnometer (range-finder). Meteorology as the Science of Wind Vortices.

Professional Notes: Naval Strength of Foreign Fleets in Cretan Waters. Launches of the English Cruisers Niobe and Doris. Shipbuilding Programmes, England and France.

April. Discussion of Problems in Naval Tactics. Outline of English Landing Expeditions. The United States Navy, 1895-

96. The Price of Armor (Report of the Secretary of the U. S. Navy). Determinate of Astronomical Base in Nova Zembla. Note upon Stoppage of Leaks in the Iron-clad Admiral Greig.

Professional Notes: English Shipbuilding in 1896. English Naval Budget, 1897. Trial of the Jauréguiberry. Spanish Torpedo-boat Destroyers Terror and Furor. A New Portuguese Cruiser. J. B. B.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

No. III, 1897. Hydrographic Remarks on the Chusan Archipelago, Woosung, and Mouth of the Yantse. Oil for Quieting the Sea. Determination of Geographic Positions on Land without the Use of Astronomical Instruments.

No. IV. Report on Drift Ice in the Indian Ocean. Mistpoeffers.

Investigation of the mysterious sounds or reports occurring along the Flemish and Dutch coasts, as well as in the interior, especially on sunny days, and designated mist-poeffers.

Hydrographic Researches in the Red Sea.

Appendix I. Middle Distances of Steamer Routes in Sea Miles.

The table gives distances between the principal ports of the world, alphabetically arranged.

MILITÄR WOCHENBLATT.

Nos. 22 to 28, March, 1897. The Attack and Defense of Constantinople from the Land Side. Condition of Greek Navy.

No. 30. American Pneumatic Guns. Effectiveness of Small Calibered Rifles.

No. 32. Increase of French Navy.

No. 37. Military and Naval Manœuvres, 1897, in Austria.

No. 39. English Field Piece of Mounted Batteries.

DEUTSCHE HEERESZEITUNG.

No. 20, March 13, 1897. The Gunners of Lissa Island.

In memory of the heroic defense of the island by the Austrian artillerymen against the attacking Italian fleet, July 18, 19 and 20, 1866.

Trafalgar and To-day (continued).

Nos. 21 and 22. Trafalgar and To-day (concluded). Italy's Naval Shipbuilding.

The following ships are under construction, time of completion 1897 to 1899: First-class battle-ship Admiral St. Bon, building at Venice, 345 feet long, 69 feet beam, 13,500 horse-power. The sister ship, Emanuel Philibert, is building at Castellamare di Stabia. Second-class battle-ships

Joseph Garibaldi and Varese, the former at Sestri Ponente, the latter at Leghorn, are of 6840 tons displacement, 13,000 horse-power, 330 feet long, 60 feet beam, armed with two 10-inch, ten 6-inch, and six 4.7-inch guns. The Victor Pisani, at Castellamare, of 6500 tons, 325 feet long, 59 feet beam, armed with twelve 6-inch, six 4.7-inch guns and two launching tubes. The Agordat and Coatit, at Castellamare, are 6th class vessels, of 7000 horse-power, 287 feet long, 31 feet beam, armed with four 4.7-inch, eight 57-millimeters and two 37-millimeters rapid-fire guns and 2 launching tubes. A torpedo destroyer, at Sestre Ponenti, of usual Italian type.

No. 23. The First German Torpedo-boat Destroyer.

Nos. 25 AND 26. Vessels of the German Navy to be Launched in 1897.

Five, possibly six, ships-of-war will be launched in Germany during the present year. The second-class cruisers K, L and Ersatz Freya will be ready in the spring.

These cruisers are of 6000 tons displacement, and correspond to cruisers 1st class of other navies. They will be fitted with cork coffer-dams, three separate engines, water-tube boilers, liquid fuel arrangements, and batteries of rapid-fire guns. The batteries will consist of two 21-cm. guns, one forward, one aft, in revolving turrets, four 15-cm. guns in turrets and four in casemates, ten 8.7-cm., ten 3.7-cm. guns and eight .8-cm. machine-guns.

The other vessels are the armored cruiser Ersatz Leipzig and the battle-ship Ersatz Friedrich der Grosse. The Leipzig is of 10,650 tons displacement, to make 20 knots with 15,000 horse-power. The battery consists of rapid-fire guns, viz. four 24-cm. 40-caliber guns in revolving turrets, twelve 15-cm. and ten 8.7-cm. guns, ten 3.7-cm. machine-guns, and eight Maxims.

The battle-ship of 11,000 tons, three engines, triple screw; armor-belt thickness up to 30 cm.; battery of four 24-cm. guns in barbettes, eighteen 15-cm., twelve 8.7-cm., twenty-four 5-cm. guns, twelve 3.7-cm. machine-guns and some Maxims, making a total armament of 78 guns.

On the Four Panama Canals and their Influence upon Ocean Lines of the World.

No. 27. Shipbuilding Program in the Reichstag for 1897.

Nos. 31 TO 37. Modern Artillery Problems Viewed from a Tactical Standpoint. The New German Cruisers.

No. 37. The Squadrons of the Powers in the East Mediterranean in April, 1897. The Italian Cei Rifle.

Nos. 38 AND 39. Reorganization of the Technical Troops.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOL. XXV, No. 5, 1897. The English Fleet Manœuvres, 1896. Zanzibar. The Turbinia. Foreign Navies.

No. 6. The New Rules of the Road at Sea. Tests of Face-hardened Nickel-steel Armor Plates.

Test of an 8-inch Creusot plate intended for the turrets of the Danish

battle-ship Skjold, and test of two Italian 6-inch plates manufactured at Terni.

England's Naval Budget, 1897 to '98. Foreign Navies.

MARINE RUNDSCHAU.

APRIL, 1897. History of the Fleet (continued). Lack of Cruisers and Utility of Cruisers. Two Episodes of the year 1798: 1, Weakness of Nelson's Fleet in Cruisers in his Pursuit of Bonaparte to Egypt; 2, The Importance of Cruisers in the Destruction of Commodore Bompart's Expedition in 1798. Floating the Grounded Russian Cruiser Rossija. Plans for the Rapid and Efficient Ventilation of Coal-bunkers without Removal of Bunker Plates. The Austrian Torpedo-cruiser Magnet, Cheops, Osakku, Jeddo.

MAY. History of the Fleet (continued). Fighting Values of the Navies of the World. A New Invention for Utilizing the Forces of Waves and Tides. The Murman coast. German Mythology in Connection with the Names given to recent German Naval Vessels. Naval Notes.

JUNE. History of the Fleet (continued). The Struggle for the East Asiatic Trade. Activity of the "Zieten." France's Sea Fishery and its Connection with l'Inscription Maritime. Upstarts in the German Sailor Language. Naval Notes.

H. G. D.

UNITED SERVICE GAZETTE.

MARCH 27, 1897. French Aspirations to Sea Power. Our Naval Resources in Time of War.

APRIL 3. The Education and Training of Naval and Military Cadets. The Influence of Public Opinion on the Navy.

MAY 15. The Entry of Naval Cadets. The Development of the Torpedo-boat.

MAY 29. The Navy and the Country.

JUNE 5. Our Proposed Standard of Naval Strength.

THE STEAMSHIP.

APRIL, 1897. The Navy Estimates, 1897-98. The New Japanese Battle-ships (illustrated). Liquid Fuel (illustrated). Harrison's Noiseless Steering Engines (illustrated).

MAY. Estimation of the Power of Steamships at Sea. A Mechanical Method of Ascertaining the Statical Stability of Ships (illustrated).

JUNE. Martin's Ship's Light Indicator (illustrated). Institute of Marine Engineers. Launch of Two British War-ships. New Method of Propelling Steamers (illustrated).

JOURNAL AND PROCEEDINGS OF THE UNITED SERVICE INSTITUTION OF NEW SOUTH WALES, 1896.

Reminiscences of the Chitral Campaign. Railways in Warfare. High Explosives and Field Fortifications.

LE YACHT.

March 6, 1897. The Use of Turbines as Motors. The Battle-ship Masséna.

The Masséna, built by the Ateliers et Chantiers de la Loire, upon plans furnished by M. de Bussy, former naval inspector, has been carefully designed both as to armament and protection. Its speed of 17 knots is considered amply sufficient for a battle-ship. Its radius of action is that pertaining to that class of vessels. Its principal characteristics are: Length, 112.65 m.; breadth, 28.31 m.; draft, aft, 8.16 m.; displacement, 11,924 tons; normal horse-power, 9200; guaranteed speed with natural draft, 17 knots.

Its armament consists of 2 guns of 305 mm., 2 of 274 mm., 8 of 138.6 mm., all in closed turrets of the Creusot manufacture. There are besides in the superstructures 8 guns of 100 mm., protected by simple shields, with numerous 47 and 37 mm. guns. The calibers 138 mm. and under are quick-firing. The 305 mm. and 274 mm. are placed, the first in the axis of the vessel, the second on the sides about amidships, each in a separate closed turret 40 cm. thick in the rotating part and 35 cm. in the fixed part down to the protective deck. The turrets are worked by hydraulic power of the Creusot system. The big guns are provided with the Farcot breech block. The 138 mm. guns are 45 calibers long. The dispositions of the batteries are such that it can fire at once 11 guns, either forward or aft, and the same number broadsides.

The Masséna has 4 torpedo tubes, 2 below water and 2 above. The steel hull is double the whole length of the ship, and carefully divided into water-tight compartments. There is no projecting keel.

Two side or bilge keels of teak wood lined over with galvanized sheets 45 cm. wide extend over a part of the ship and contribute to the platform stability. The stem of forged steel has the sharp, slender shape of the cruisers of the Bussy types, favorable to speed, and free the heavy waves forward when going at a rapid rate. The stern-post of cast steel. The armor protection is ample, representing 4000 tons in a 12,000 ton displacement, or one-third the total weight. Above the protective deck extends a continuous line of cofferdams with an outer light plating called the cofferdam plate. Floatability thus seems secured in nearly every case incident to battle. The vitals are protected against the action of powerful explosives, first by the belt of cofferdams, which will cause them to burst outward, and then by the splinter screen deck in case of portions of the main deck being broken off. In short, in regard to the composition and distribution of its armament, the Masséna is decidedly an improvement upon all former constructions and has no superior in any navy.

March 13. The Fleets of Greece and Turkey. The Coast-defense Vessel Amiral Tréhouart.

March 20. The Navy Estimates in the French Senate.

March 27. The English Naval Budget.

April 3. The Duration of Acceptance Trials in France.

April 10. The Harbor of Bizerta.

April 17. The Appropriation for the New Constructions.

The composition of the fighting units in the programme before Parliament to be carried out between now and 1905 is as follows: 6 battleships, 22 cruisers, 7 despatch or station gunboats, 35 despatch torpedo-boats or destroyers, and 150 sea-going or coast defense torpedo-boats.

April 24. The Graeco-Turkish War on the Seas. The Decimal Time (Hour).

May 1. The Accident on Board the Russian Battle-ship Sissoï-Veliky.

May 9. Stability and Floatability during Battle. The Prince George.

May 15. Orientation of the Submarine Boat, with Reference to the Enemy.

Considers the various means of locating the enemy's vessel from an approaching submarine boat. The optical tube with mirrors; the periscope of Major Daudenart, which takes instantaneous photographs, all present objectionable features. Mirrors become dimmed, they are visible from afar, for their use the boat must be near the surface. The simplest plan and best under these circumstances is to rise to the surface and use the direct vision through the air.

If close to the enemy, the conditions are different, and the best means of steering for him are yet to be solved. Lateral submerged mirrors, capable of adjustment from the interior of the boat, are suggested. The use of oil is advocated for calming the sea above. Visibility under water is under most favorable circumstances very limited. Results of Mr. Herman Fol's experiments are quoted. As a last resort is suggested a means of locating the exact position by a sounding apparatus, used in connection with the depth registering apparatus, and a chart of the waters operated in, giving in minute details the depths and hydrographic features, so that the boat can feel its way along in the dark, as it were.

Trials of the Turbinia.

May 22. Germany's Naval Strategy. The Spanish Cruiser Cristobal Colon.

Gives full description with two illustrations.

Merchant Marine.

May 29. Propositions of M. Lockroy with Reference to Naval Program. Industrial Progress of the Arsenals. J. L.

REVUE MARITIME.

January, 1897. Geometry of the Diagrams. Medical Service on Board in Action. Development and Progress of the German Navy. A Note on the Use of Torpedo-boats.

February. A Memoir: Delivery of Toulon to the English in 1793. Aerial Currents; their Courses, and their Utilization by

Aerostats. The Atmometer, "an ingenious device for measuring evaporation."

MARCH. Geometry of Naval Tactics. Study of Budget Specialties. Air Currents, their Direction and Utilization. Method of Indicating Courses Steered at Night by a Steamer.

APRIL. Reports on Macassar collected by the Duguay-Trouin. Air Currents (continued). Study of Budget Specialties (concluded). J. L.

LE MONITEUR DE LA FLOTTE.

MARCH 6, 1897. The Crisis in the Merchant Navy.

Statistics show that for several years past the sea commerce of France has been steadily declining. Time and again laws have been enacted in Congress to check the evil, but they have been powerless in arresting the downward movement.

In 1881 a system of premiums to construction and navigation was established; but the law only covered a period of ten years, and although continued with slight modifications up to the present time, it failed in its ends, owing to the uncertainty of its provisions. The consequences are that the French ship-yards, once so active and prosperous, are now nearly deserted; ship-owners finding it to their advantage to buy their vessels in foreign countries, principally in England.

MARCH 13. Naval Programs.

In 1891, M. Barbey, then Minister of Marine, presented a program which was at first favorably viewed by Congress. But the following year the naval committee cut down the appropriation, and the result of this dilatory policy has been that an extraordinary effort is now made necessary in order to return the navy to its proper standard. If the program of 1891 had been carried out in its integrity, the government would have built or put on the stocks since January 1892 50 fighting units, exclusive of torpedo-boats. Actually it can only reckon on 35, or 15 units less than proposed, to wit: 3 battle-ships, 6 armored cruisers, 6 torpedo-catchers or destroyers, etc. Hence the reason for the enormous appropriation asked for this year for new constructions. It has been decided in the new naval program that the actual, whether afloat or building, shall be increased by 220 new fighting units of various types: 6 battle-ships, 22 cruisers, 7 despatch or station gun-vessels, 35 despatch torpedo-boats or destroyers, and 150 sea-going or coast defense torpedo-boats, construction to begin at once and to be pushed rapidly to obtain the needed units. Eighty millions of francs over and above the yearly appropriation are thus to be distributed over a period of eight years.

APRIL 17. The Composition of the Fleet.

The promulgation of the new naval construction could not fail to awaken, and has as a matter of fact revived in all its bitterness the smouldering discussions and polemics touching the respective value of the units composing a modern fleet. The scoffers and revilers of the armored battle-ship have resumed their criticisms of what they call derisively the "Mastodons" and "Cathedrals" of the sea; once more they have denounced the "folly," the "stupidity" of those who assume that given

certain circumstances, the battle-ship is a weapon of war of no mean value. They proclaim that the cruiser answers every purpose, and should therefore enter alone in the composition of a fleet. On the other hand they have purposely avoided mentioning the tonnage of the cruiser of their choice. Shall it be a large cruiser or a medium size one? Will it be a heavily armored cruiser, a protected cruiser, or simply a commerce destroyer (pirate-cruiser)? They are studiously vague on this, a most important point. It is no part of the discussions of these gentlemen to enter into details, to follow closely the data of the problems. Their rallying cry is, "Death to the Mastodons, fatal only to their own crews." They will not listen to other arguments, and after proclaiming the exclusive use in the navy of high speed vessels with great radius of action, they feel confident they have proved their case. What is gall to the champions of the cruiser, what is beyond their comprehension, is that the new building program should contain a proviso for the immediate construction of six battle-ships. They seem to lose sight of the fact that the Triple Alliance have numerous battle-ships afloat and are building many more. They also forget that victory must belong to the one whose power of resistance is most enduring. They make a great ado about end-on attacks in which light plates will offer as much resistance as thick plates. Yet nothing is more problematic than such theory. . . On the other hand, is has been advanced that the monitor (sea-going monitor) might probably supersede with advantage the ordinary type of the modern battle-ship. Such a vessel would possess some striking analogy with the ship designed by M. Bertin, in course of construction at Cherbourg, and named Henri IV.

MAY 8. The Composition of the Fleet, III. J. L.

REVUE DU CERCLE MILITAIRE.

FEBRUARY 27, 1897. Projected Tactics Regulations for the Russian Infantry. French Military Arts at the Brussels Exposition of 1897. An Historical Account of the Madagascar Expedition.

MARCH 6. The Niger Hydrographic Mission. An Historical Account of the Madagascar Expedition (continued).

MARCH 13. Probable Lines of Operations in the Event of a Conflict between the Franco-Russian Alliance and the Triple Alliance.

A very interesting study.

MARCH 20. The History of the Military Folding Bicycle. An Account of the Expedition to the Island of Madagascar (with photographs).

MARCH 27. Preparatory Military Instruction. A Pocket Field Glass.

APRIL 3. An Expedition into the Heart of Africa. Preparatory Military Instruction (continued).

APRIL 10. The Madagascar Expedition.

APRIL 17. Field Artillery Tactics.

MAY 1. Military Shelter Cabins in the Swiss Alps.

MAY 8 AND 15. The Irish Brigade in the French Service. German Warfare in East Africa.

MAY 22 AND 29. German Warfare in East Africa (continued). The Landside Defense of Constantinople. Entrance Examinations to Naval School in 1897. J. L.

SOCIÉTÉ DES INGENIEURS CIVILS.

JANUARY, 1897. A Study of a Type of Navy Marine Boiler.

The boiler must present the following characteristics: 1st, Strong with a least liability to explosion. 2nd, Sufficiently low built to allow of its installation under the armored decks, and compact, in order to take as little space as possible in all directions. 3rd, Capable of supplying at a given moment a considerable quantity of dry steam. 4th, Moderately light so as to permit a greater stowage of fuel and ammunition and an increase of armor protection. 5th, Capable of sustaining without risks the most sudden changes in the rate of steaming. 6th, Easy for handling and repairing with the means on board. 7th, Ready at the shortest notice in cases of emergency, and so constructed that spare pieces may be taken on board. 8th, Saving in fuel. 9th, Moderate in cost.

FEBRUARY. A French Expedition in a Balloon to the North Pole, by M. Surcouf. An Essay on the Determination of the Form of Least Resistance to the Motion of the Submarine Boat.

MARCH. Railroad from Senegal to the Niger. The Manufacture and Industrial Uses of Ozone. J. L.

REVISTA TECNOLOGICO INDUSTRIAL.

FEBRUARY, 1897. A Note on the Starting of a Train and a Means of Facilitating the Operation.

MARCH. Electrical Transmission in Industrial Establishments.

APRIL. The Engines and Boilers of the Emperador Carlos V. (with two plates). Electrical Transmission in Industrial Establishments.

REVISTA MARITIMA BRAZILEIRA.

MARCH, 1897. The Knowledge of a Naval Officer.

La Marine Militaire published some time ago an article under the *nom de plume* of Jean de la Poulaine, in which the writer pretends to prove that of all naval officers of the European or North American navies, the English are the most deficient in general knowledge. This assertion is based, it must be understood, upon the insufficiency of the scientific education received by the cadets on board the Britannia, and later, as midshipmen on board men-of-war.

APRIL. Organization of the Brazilian Navy. The Obry Apparatus for Regulating Torpedoes. Problems in Naval Strategy.

RIVISTA DI ARTIGLIERIA E GENIO.

April, 1897. Firing Tables. The Defensive System of the Tyrol. Hotchkiss Automatic Gun. New Artillery Firing Instructions. Miscellaneous Notes.

May. The Rifle which does not Kill. Effects of Bullets from Small-calibered Rifles. The Theorem of Least Stress Applied to the Shrinkage of Gun Hoops. How to Compare Firing Exercises, Infantry and Artillery. Carrier Pigeons for Military Uses. Theory of Coast Artillery. Regulating the Fire of a Battery. Miscellaneous Notes.

BOLETIN DEL CENTRO NAVAL.

February and March, 1897. Spontaneous Combustion of Coal Aboard Ships. Official Inspection of the Squadron and Report of the Board. Brief Points on Modern Naval Warfare (continued). New Victory of Gun over Armor. Naval Ordnance in Connection with Old and Modern Powders.

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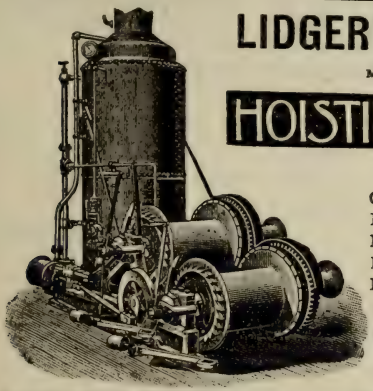

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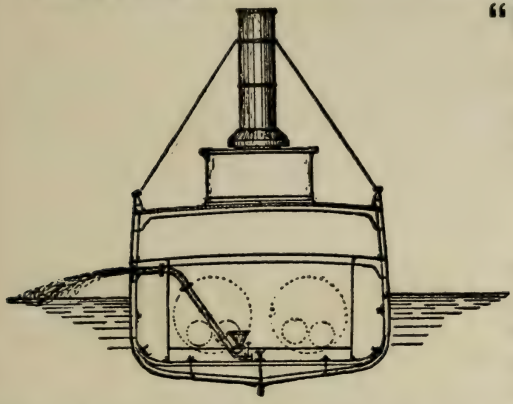

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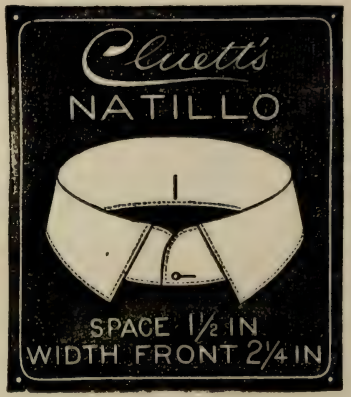

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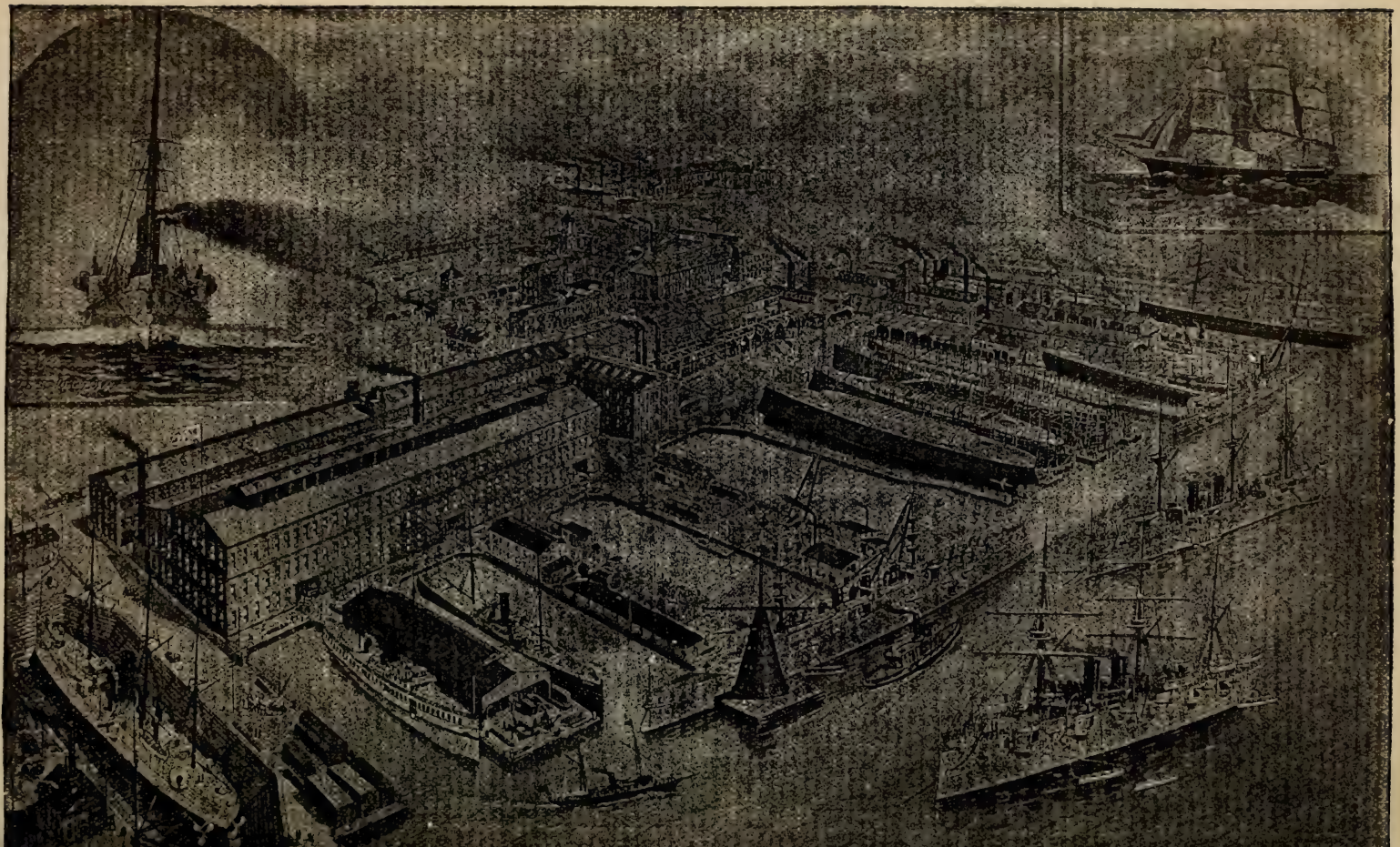

Vol. XXIII., No. 3. 1897. Whole No. 83.

PROCEEDINGS

OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XXIII.

EDITED BY H. G. DRESEL.

PUBLISHED QUARTERLY BY THE INSTITUTE.

ANNAPOLIS, MD.

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THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Whole No. 83.

ERRATUM.

On page 362, whole No. 82, fourth paragraph, second line, for "1-pounder" read "machine gun."

Nearly all ships of our navy are now equipped with automobile torpedoes, while only a small percentage of our officers and men are as yet instructed in their use. In many cases, therefore, these weapons must be assembled, adjusted and fired by inexperienced hands or left as idle material in the hold. Their large cost, their vessel-like structure and their occasional and seemingly inexplicable disappearance in target practice, naturally make officers chary about using them. Even the most experienced torpedoist learns something new about their behavior at almost every exercise run.

If we are ever to progress with this weapon, however, it must not be regarded as a costly, erratic and fragile vessel, but as a projectile subject to expenditure in target practice like a common shell. From our battle-ships we shall throw fourteen thousand dollars worth of ammunition annually into the sea, and we regard the experience to be gained a full repayment, yet we know

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HONORABLE MENTION, 1897.

MOTTO: "And another came, saying, Lord, behold, here is thy pound, which I have kept laid up in a napkin: for I feared thee, because thou art an austere man."

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TORPEDOES IN EXERCISE AND BATTLE.

By J. M. ELLICOTT, Lieutenant, U. S. Navy.

Nearly all ships of our navy are now equipped with automobile torpedoes, while only a small percentage of our officers and men are as yet instructed in their use. In many cases, therefore, these weapons must be assembled, adjusted and fired by inexperienced hands or left as idle material in the hold. Their large cost, their vessel-like structure and their occasional and seemingly inexplicable disappearance in target practice, naturally make officers chary about using them. Even the most experienced torpedoist learns something new about their behavior at almost every exercise run.

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far better how to use the gun than we do how to use the torpedo. If we exercise as often with torpedoes as we do with powder and shell there might be one or two torpedoes lost from a ship in a year. The Whitehead costs, exclusive of accessories, about $2000 and the Howell about $1500, so that an expenditure of $3500 a year, or one-fourth a battle-ship's expenditure of ammunition, is a reasonable estimate for torpedo practice. The fact that the torpedo is a recoverable projectile should make its use even more frequent than the use of great-gun ammunition. I would advocate torpedo target practice once a week, either stationary or moving, in port or at sea, and that, if possible, every torpedo in the ship be used at least once a month. Each has its individual eccentricities which can only be learned by using it. Each will behave differently under different conditions, and its behavior should be learned in smooth water and in rough water, in salt water and in fresh water, when full-charged and when under-charged, with air leaks and without them, and at various angles of train and depression.

After a careful study of foreign automobile torpedoes before the United States commenced their manufacture, and after a subsequent course of instruction at the U. S. Torpedo School, I found myself upon one of our modern cruisers equipped with above-water, broadside-pivot launching tubes for Whitehead torpedoes and a fixed bow tube for Howell torpedoes. She carried U. S. Navy Howells and Whiteheads, Mark I., and a Brotherhood air compressor with its separator, but no accumulator. The bow tube, as the ship was customarily trimmed, had 45′ elevation instead of the customary 3° depression. When I prepared to exercise with this outfit the torpedoes were boxed in sections in the hold, their brackets and trolleys were not installed and the tubes and air compressor had never been used. As torpedo officers may frequently have to start from this point, I think it well to suggest in detail a method of procedure, endeavoring not to duplicate but to supplement the very excellent books now being issued by the Navy Department for general guidance.

Assembling the Whitehead.

A ship will receive her torpedoes boxed in four sections, viz: the war head, the exercise head, the middle section and the after body. The sections will be found in neatly fitting chocks inside

the boxes, and these chocks can be lifted out and used as rests in assembling. The sections should be carefully examined inside with lighted tapers before assembling, for some movable parts may be tied with twine, or foreign substances may have fallen in. Care should be taken, however, not to bring lighted tapers in contact with springs, as it might affect their elasticity.

It is also important to make sure, by corresponding numbers on the parts of the torpedo, that you are putting together sections of the same weapon. When I assembled my first Whitehead I relied upon the numbers on the outside of the packing cases, and inadvertently attached the after body of one torpedo to the air flask of another. Some excellent runs were made before my mistake was discovered. The card adjustments for the air flask number were used without change, except for the vertical vanes, which had to be set at — 8 instead of + 2.

Before assembling the Whitehead make the following tests:

1. Remove the charging check valve; open the stop valve; sling the air flask upside down and with its forward end 60° upward, so that if any water is inside it may drain out.

2. Turn the flask right side up and level; replace the charging check valve; tilt the flask up and down, using the pendulum level, and note at what angle each way the horizontal rudder rod begins to move through the bulkhead. It should not be far from 3°, but if it is widely different, the immersion mechanism must be removed and the equalizing springs of the pendulum adjusted. The so-called pendulum level is a sluggish instrument and must be tilted in use so that the bob will swing free from the graduated surface.

3. Take off the immersion chamber bulkhead and examine its gasket. If it is defective put in a new one. At the same time make an examination of the chamber to see that it is clean and dry. Set up the bulkhead nuts equally and tight in closing this chamber.

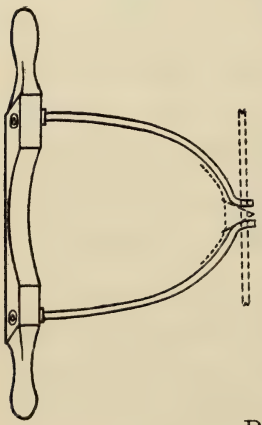
4. Place a push-balance (one will be found in Howell Accessory Box No. 1) against the hydrostatic piston; set the depth index at 5 feet and push on the balance until the rudder rods move. Note the registered pressure, which should be 29 lbs. for Whiteheads now in service. Make a record of the amount of difference if it is appreciable.

5. Remove the engine bulkhead; examine the gasket and re-

new it if necessary; examine the interior of the after body; replace the engine bulkhead and set up all the nuts alike and tight.

The after body may now be connected up to the air flask. While doing so, the ratchet bar of the locking gear must be kept pressed back until the ratchet wheel spindle passes under it, and care must be taken that the end of the rudder rod and of the steering engine valve stem do not butt against each other. After setting up the joint-screws place the screws in the valve stem joint and the air pipe flange. Great care must be taken in connecting up the valve group. The screw connecting it to the engine casting should be left slack until those in the flanges are set up, and all four of the flange screws should be set up alike, a little at a time on each until all are quite tight. Inequalities in this work will be a sure cause of air leaks.

The exercise head is very awkward to handle, especially when filled. To fill it, remove the nose and rest the head, small end down. Fill with clean, fresh water until it is above the bulkhead flange, and set up the bulkhead nuts with the bulkhead awash, so as to insure no air space inside. The wash of water in a partly filled head will seriously affect a torpedo's course.



A rack for transporting the filled head can be made on board ship, as shown in the sketch. Such a rack is used at the Torpedo Station and on board the cruiser I have mentioned. The head once filled can remain so for any desired length of time, but it would be a good precaution to refill it once a quarter, or oftener if it seems to leak, making sure that the interior is free from rust.

Preparing the Tube.

A new tube must be carefully examined before attempting to fire a torpedo from it. The following procedure is suggested:

1. Measure the drop of the tripping latch inside the tube and ascertain if it is sufficient to trip the starting lever of the torpedo. A lump was found on the surface of the tripping latch slotway in one of the tubes under my care, which restrained the latch half an inch short of its full drop. It was an excrescence in the casting and had to be filed off.

2. Note, when the firing lever is hooked up, if the stop pin projects into the guide stud groove.

3. See if the tube door closes tightly. If it seems loose when latched, slack off the tap screws in the catch and drive down the wedge.

4. Thoroughly lubricate the elevating and training gear, and work both gears to their limits until they can be operated with but little effort. Note, by looking through the tube at extreme train each way, if the torpedo upon discharge will clear the sides of the port. Note the same for extreme depression and 5° elevation. See that the port shutter when opened swings entirely clear of the port.

5. Set up the compression band nut until the band is plainly visible inside the walls of the tube all around. Lubricate the tube thoroughly with vaseline, enter the torpedo and shove it home until it jambs. Keep two men steadily shoving on the torpedo with the rammer and slack off the compression band nut until they can just push the torpedo home.

Testing the Charging Arrangements.

The air compressor can be tested by placing a blank flange in the charging pipe union at the separator and running the pump until the gauge registers full pressure. When this pressure is attained, slack off the safety valve until air just begins to escape from it. Blow off the air from the separator through the drain cock at its bottom.

Whitehead torpedoes should be so stowed in their racks that their port sides would be inboard and accessible. There should be two charging pipes, so that the torpedoes can be charged either in their racks or in the tube, but if only one is furnished, bend it for charging the torpedo in the tube. Charging pipes, being of copper, may be bent cold by hand to the most advantageous shape for charging, but if a very sharp bend must be made the pipe should be first filled with resin.

Testing the Regulators.

Charge the torpedo to about 800 lbs. pressure; fill the engine and valve group oil pots; remove the engine room door and proceed as follows:

1. Secure the lock of the propellers; compress the regulator spring two turns; open the stop valve one-half turn; lift the starting lever and, with a lighted taper, examine for air leaks (a) around the follower ring over the reducing valve, (b) at the joint between the valve group and engine, (c) around the stem of the controlling valve, (d) around the engine valve chest bonnets and cylinder heads, (e) around the unions of the steering engine pipes, (f) around the crank case cover, (g) around the steering engine stuffing boxes. This examination must be made rapidly and the starting lever closed when it is over. Set up with the proper tool when a leak is found.

2. Lay the horizontal rudder in the plane of the axis of the torpedo by aligning it with a straight edge along the horizontal tail frame; set the rudder index to 0° of the scale on the vertical frame; throw back the starting lever and note if the rudder drops down 1½ to 2 marks on the scale. Move the controlling valve of the steering engine back and forth and see if the rudder responds with a throw of 4 marks down and 3 to 3½ up. If it has a different set and throw, adjust by the valve star until the above is attained. A set screw in the valve star must be slacked before the latter can be operated, and this should be set up again after adjustments are made.

Place the testing lever (tool 36) on the hydrostatic piston and press it forward, noting if there is ¼ to ½ mark less up rudder than down. The full throw of the horizontal rudder may be increased or decreased by unscrewing the rudder rod from the bell-crank at the tail and giving the rod one or more full turns. Each turn alters the throw of the rudder ¾ mark. In the Mark I. torpedoes the tail has to be removed to make this adjustment.

When adjusting the rudder, only lift the starting lever long enough to verify each adjustment, so as to expend as little air as possible.

3. Lock the horizontal rudder with two teeth of the ratchet bar engaged. Note if it is locked at the inclination required by the adjustment card. If not, turn the locking star until this inclination is indicated by the rudder index. The locking star pawls twelve times in one revolution, and six pawls change the inclination of the rudder one mark. Set the distance gear sector two teeth. Slightly raise the starting lever and let the engine revolve slowly until the distance gear stops it. See then if the ratchet bar has unlocked the rudder.

4. See that the sinking valve (if any) seats securely in its bulkhead.

5. Replace the engine room door, being careful to see that the water tripper bell-crank stud enters the jaws of the retarding lever; also that the tripper operates freely.

Preparations for Firing.

These will be found in the Drill Book, but the following precautions are suggested by experience:

Drain Holes and Plugs.—There are two in the immersion chamber and two in the after body. Both in each compartment must be removed to insure drainage. New drain plugs always have burrs in the wake of the slots in their heads, which must be removed to insure complete closure. The drain plug for the transportation screw hole is kept in the head of the transportation screw, but all drain plugs are alike and interchangeable. Drains should be left open while torpedoes are in the racks.

Oil Pots and Oil Ways should be filled before every run. The consumption of oil is very great.

When using registers a washer must be placed under their flanges to insure a water-tight joint. When a register is used, load the torpedo home very gently if the port is closed, for the register fan has been known to take against the port shutter and get bruised. In such a case the shutter must be started in order to complete the loading without injury. No scale is furnished with the depth register card, so that the curve traced only indicates relatively the immersion during the run. If the immersion is co-ordinated by nets, however, a scale can be constructed. The torpedo officer on board ship should do this if the opportunity is presented. The rolling register need only be used when improper trim is suspected of being the cause of lateral deviation.

Precautions in charging.—The portable pressure gauge should be used to ascertain if any air is in the flask before charging. If there is already some pressure, the stop valve must be closed, the charging pipe connected and the compressor run until the pressure in the charging pipe equals that held in the flask. Then open the stop valve and finish charging. If charging from accumulators this precaution is unnecessary.

When the flask is charged the stop valve should be closed and the air backed out of the charging pipe before removing the

wing nut. This can be done by lifting the starting lever, keeping the propellers locked, or by opening the drain cock under the separator, or by both methods at once. If charging from accumulators, close accumulator stop valve as well as flask stop valve before draining off.

Should full pressure be obtained abnormally soon when charging, the stop valve is probably only partially open or has been inadvertently left closed.

Depth Index.—As soon as possible in practice it should be learned at what actual depth each torpedo runs for a given setting of the index. A small correction to be applied to the index may thus be discovered and should be recorded on the adjustment card together with the density of the water in which it was obtained. The depth index is marked for water of specific gravity 1.026. In fresh water the torpedo should run nearly one third of a foot deeper than the register calls for. Be sure to set up the jamb nut after setting the depth index, for if it is loose the immersion chamber may be flooded during the run.

When *the distance gear* is set by the card the torpedo may exceed the corresponding range as much as 100 yards. This must be kept in mind when looking for a clear range in confined waters. If the point of broach is co-ordinated several times, a closer approximation to the proper distance gear adjustment may be made than that given by the card.

The regulator spring of the reducing valve has adjustments recorded on the adjustment card for flask charged to full pressure. When there is a lower flask pressure the spring must be under smaller compression to maintain uniform speed, and uniformity in speed is very essential to a straight run. The proper allowance for different flask pressures can be obtained, as will be shown later.

If the vertical vanes should have *plus* adjustment the starboard vane is set; if *minus*, the port vane is set, the other vane remaining at zero. If the torpedo needs more helm than the vanes will give (8 marks), file the proper slotway longer. Resort to this, however, only after diligent search for the cause of deviation.

The water tripper has sometimes failed to operate, but the failures have been so infrequent that it may be used with confidence in exercise. Its disuse causes no immediate injury, but probably shortens the life of an engine. In a battle run it is best not to use it.

Be sure that the *firing lever* is hooked up before ramming home. Listen for the snap of the *tripping latch* over the guide stud, and if it is not heard, sound with the latch lever to see if the latch is resting on the torpedo. When the torpedo is home work the firing lever up and down to see that the stop pin is not jammed against the guide stud, but do not do this with the port open and ship rolling, without keeping hold of the torpedo by the tail line. Before closing the tube door turn the propellers until the notch on the propeller shaft is at five o'clock (⇘) to insure the engine being off the center.

Torpedo Target Practice.

Suggestions as to the choice of a range will be found in the back of the Drill Book.

A distance line 200 feet long, stretched between two anchored buoys, makes a suitable target. Every 25 feet along the line should be marked by floats and flags, placing a red flag at the center, white flags next each way, then blue flags, then white again. An observer in a boat lying near the line could then easily tell under which space the torpedo passed. Every ship, however, should be furnished with a net 200′ by 10′, with meshes about 4″ square, fitted with corks to float it and leads to keep it vertical, to be used as a target when making the annual verification of torpedo adjustments.

There should be no hesitation whatever about conducting torpedo practice in favorable weather at sea, provided that torpedoes are used which have proven their good behavior in harbor practice. Commanders should not be condemned when torpedoes are occasionally lost in this way, but should be encouraged to exercise with them under sea conditions. An empty pork barrel is a sufficient sea target, with a whale boat near at hand to recover the torpedo. Such practice should be "moving" at standard battle speed, and it could be plotted from the following observations:

An observer abreast the tube will note by a Pelorus the azimuth of the target from the ship's course at the instant of firing, and again at the instant of broach. A second observer at the same place will observe with a T the angle between the target and the torpedo when it broaches.

The number of revolutions of the ship's engines from the instant of firing to the instant of torpedo broaching will be noted, from which to obtain the distance run by the ship, for it is wanted with accuracy. This will give the base line *AB* in the diagram when plotted to scale, and from the target azimuths taken at *A* and *B* the position of the target *C* can be plotted. The T-angle taken at *B* gives the line *BP*. With *A* as a center and a radius equal to the run for which the torpedo was set, with its correction if known, find *P*. Join *AP* and draw *CD* perpendicular to *AC*. *CD*, when measured, will give the lateral deviation of the torpedo. Its depth register will indicate its immersion.

Instead of observing target azimuths at *A* and *B*, the distance of the target from these two points might be determined by Buckner's method, and its position plotted by intersecting arcs.

Recovery after Firing.

General instructions will be found at the back of the Drill Book. To use the nose line properly, pass the plug through the hole in the exercise nose and take two half hitches with the bight of the line around the end of the plug. If a register is in the head, the torpedo should be towed home tail foremost by the tail line taken around the after body just forward of the tail frames and hooked to its own part. If the tail line is hooked in the propeller lock and the torpedo is towed in a seaway, there is danger of jerking the lock off the propellers.

A torpedo is in greatest danger of injury while being hoisted on board and struck below. There should be no necessity for doing this. A small davit could be fitted to the ship above the torpedo port in such a position that the torpedo could be hoisted clear of the water, then the tail line passed in through the tube and the torpedo pointed tail in and hauled through. The port shutters now fitted to open upwards would be a hindrance to this, but they are clumsy things anyhow and, I believe, could better be replaced by sliding shutters or double shutters hinged at their sides. Even with the present shutter, a portable bracket having

a guide stud groove could be fitted in the mouth of the tube after firing, which would project a little beyond the outer edge of the lifted shutter, or the latter could be fitted to swing up flat against the side or to be easily unshipped during torpedo practice with the aid of the davit described.

Density of the Water.

The weight of the present U. S. Navy Whitehead torpedo ready for an exercise run is 836 lbs. Its displacement when submerged in sea water (specific gravity 1.026) is 838 lbs. Its displacement in fresh water is, therefore, 817 lbs. If the density of the water is 1.023 or less, the torpedo when first discharged is not buoyant. If by any chance the torpedo then fails to run it will sink, and in absolutely fresh water it will go down with the very appreciable weight of 19 lbs. Consequently, when discharged in our bays and rivers or in the lakes, a fully-charged torpedo which fails to run is going to sink at once and be temporarily, if not altogether, lost. The weight of air in the flask, however, at 1350 lbs. pressure, is 50 lbs., so that if the flask is not charged to full pressure it will have additional buoyancy. Until a ship's torpedo installment has been sufficiently tested to make the failure of a torpedo to run after discharge extremely improbable, the density of the water at the range should be obtained before practice, and the air flasks under-charged in accordance with the following table:

Table I.

Density of the Water.	Flask pressure which will insure 2-lbs. buoyancy.
1.0260	1350 lbs.
1.0235	1300 lbs.
1.0210	1250 lbs.
1.0185	1200 lbs.
1.0160	1150 lbs.
1.0135	1100 lbs.
1.0110	1050 lbs.
1.0085	1000 lbs.
1.0060	950 lbs.

Below a density of 1.006, which is that of the water in the upper Chesapeake and Delaware Bays, the flask pressure would have to be carried too low for a working pressure in order to insure initial buoyancy, so the precaution then becomes impossible and

a return to full pressure may as well be made. In water absolutely fresh a loss of flask pressure of 570 lbs. insures buoyancy with our Mark I. Whitehead, and as more than this is always lost in a 400-yd. run, there is no danger of a fully-charged Whitehead lacking buoyancy at the end of a run unless it leaks.

The density of the water seems also to affect the range. In water nearly fresh the torpedo will considerably overrun the distance for which it is set. It is important to keep this in mind if there is not much clear water beyond the range.

When the initial flask pressure is less than 1350 lbs., the adjustment of the regulator spring per card will be at too great a compression to give uniform engine pressure throughout the run, and the torpedo will be slowing down toward the end of the range. Uniformity of speed is very essential to a straight course, so the proper adjustment of the regulator spring for a series of initial pressures from 1350 to 1000 pounds should be obtained and tabulated. With this end in view I made the following experiments with Whitehead No. —:

A valve chest bonnet was removed and a nipple screwed in its place, on which was screwed the portable pressure gauge.

The air flask was charged to 1200 lbs., the propellers locked, the regulator screwed down one turn at a time, and between each turn the starting lever was thrown back and the pressure at the engine noted. This was done several times both while compressing and releasing the regulator spring, with practically the same results, which are shown in the following selected table:

TABLE II.

Turns of Regulator.	Flask Pressure.	Engine Pressure.
13	1200 lbs.	950 lbs.
12	1175 "	950 "
11	1125 "	950 "
10	1100 "	950 "
9	1050 "	900 "
8	1025 "	850 "
7	1000 "	750 "
6	975 "	650 "
5	960 "	550 "
4	950 "	450 "
3	940 "	350 "
2	930 "	250 "
1	920 "	150 "
0	910 "	000 "

Six series of tests were made, beginning with different turns of the regulator. It is probable that the statical engine pressures recorded are in excess of the pressures when the torpedo is running. The results show that ten turns of the regulator give the maximum engine pressure in this torpedo, and that, when wide open, the reducing valve cannot admit air to a greater pressure than 950 lbs., while from eight turns down to one turn each turn of the regulator changes the engine pressure 100 lbs.

An examination of a large number of general practice records indicates that the loss of pressure in the air flask is 650 lbs. for 400 yds., and that this seems to be nearly independent of the initial pressure. Therefore, by subtracting 650 lbs. from the initial flask pressure we will get the final pressure after a 400-yd. run, and this final pressure will evidently be the maximum engine pressure which can be carried throughout the run. Taking it into the column of engine pressure given above, the corresponding number of turns of the regulator will be found.

Tables 1 and 2 may be combined for any one torpedo and may be found approximately applicable to all Whiteheads of the same mark.

TABLE III.

Density of the water.	Charge Flask to:	Corresponding Engine Pressure.	Set Regulator:
1.0260	1350 lbs.	700 lbs.	6½ turns.
1.0235	1300 "	650 "	6 "
1.0210	1250 "	600 "	5½ "
1.0185	1200 "	550 "	5 "
1.0160	1150 "	500 "	4½ "
1.0135	1100 "	450 "	4 "
1.0110	1050 "	400 "	3½ "
1.0085	1000 "	350 "	3 "
1.0060	950 "	300 "	2 "

REMARKS:—Measure the density of the water at the range with a hydrometer; charge the air flask to the corresponding pressure in the table and set the regulator for the corresponding number of turns. The table can be used to get the regulator adjustment when from any cause the flask is under-charged.

It will take about an hour to obtain the data for such a table from any torpedo, and perhaps half an hour to tabulate it.

The Whitehead torpedo loses 1050 pounds pressure in an

800-yard run, so that a uniform run can only be maintained with about 300 pounds engine pressure when the torpedo has been fully charged. This would give slow speed, and as a matter of fact the regulator is set for at least twice this engine pressure and the torpedo is slowing rapidly after 600 yards. This is perhaps the chief cause of inaccuracy at the 800-yard range, and 600 yards may be assumed to be the maximum effective range of the Whitehead now in our service.

Mishaps; their Probable Causes and Remedies.

1. *Torpedo fails to run.*—It will be driven about thirty yards by the powder impulse and will then lie idle on the surface or sink, according to the density of the water. Approach the torpedo cautiously, being careful not to jar it or strike its propellers until the starting lever is closed, for its engines may be on the center, and if accidentally thrown off, the torpedo would bolt and run wild. If the starting lever is not thrown back the trouble is with the tripping latch in the tube. If you find the lever thrown back, see if the lock has been left on the propellers. If all else seems right, see if the stop valve is open.

2. *Torpedo sinks.*—Locate it by the rising bubbles and buoy the spot promptly. Grapnels, oyster rakes, purse nets and shark hooks are all good things to use in recovery, but if a diver is available he should be sent down without delay. The torpedo, being almost buoyant, may be drifted some distance by currents each time it is disturbed when dragging for it, and its location might thus ultimately be lost. When recovered, locate the flooded compartment. If it is the immersion chamber, see (a) if the drain plugs have been left out, (b) if the depth index jamb-nut is loose, (c) if the hydrostatic piston diaphragm is torn, (d) if the outside shell is punctured, (e) if the steering rod bell-crank stuffing box needs packing, or (f) if the bulkhead gasket is worn out.

If it is the after body, see (a) if the drain plugs have been left out, (b) if the sinking valve is unseated, (c) if the outside shell is punctured, (d) if the bulkhead gasket is worn out, or (e) if the after stuffing boxes are tight.

Lateral Deviation.—This may be due to slight eccentricities in the torpedo's form, to its not leaving the tube in the exact direction of the axis of the bore, to air leaks, or to the unequal sluing efforts of the tandem propellers.

The torpedo is made as nearly symmetrical in form as is mechanically possible, and its remaining eccentricity should be easily compensated by the vertical rudders.

The torpedo fits loosely in its tube except in the wake of the compression band. As soon as its greatest diameter has passed this band the impulse gases might throw its tail on a slight slant one way or the other according to their wave motion at that moment. Such is generally found to be the case, and for any one tube the slant produced appears to be about the same in amount and direction if the same weight of impulse charge is used. This is, therefore, a permanent angle of error to be allowed for in training the tube.

All air leaks will be into the engine room. The engine room shell is perforated in a great many places, but all holes in it except three are either on top or are symmetrically distributed.

Air leaking into the engine room during a run will promptly rise to its crown and should find sufficient outlet upward through the various holes there, but if the leakage is rapid the air may seek egress through the two holes on the starboard side through which tool No. 4 is inserted to set up the joint screws connecting the air pipe to the valve group. Such egress would tend to throw the tail of the torpedo to port and cause it to deviate in a curve to the right. This theory has been advanced by several experienced torpedoists. To test it I permitted an appreciable air leak into the engine room of torpedo No. — and gave it two runs with vertical vanes at 0°. Before the second run I closed the two unsymmetrical holes in the starboard side with cork plugs sheared close to the skin of the torpedo. The deviation was practically the same in each case: about 75 yards to the right at 400 yards from the ship. I then tightened the leaky joint, removed the plugs and again ran the torpedo with the same result. It seems to me, therefore, that the effect of air leaks upon the course of the torpedo is immaterial, and I look for the cause of lateral deviation in another direction. Experience has shown that the deflection is, before adjustment, almost invariably to the right. This indicates that in designing the propellers no account is taken of the greater sluing effect of the after propeller due to its greater distance from the center of gravity of the torpedo. Considering the lower blades only, they being in the denser water and having the preponderating effect, it will be seen that, if the

blade areas are equal, the after lower blade in its sweep to starboard has a tendency to slue the tail to the left, greater than that of the forward lower blade in the opposite direction, because the leverage around the center of gravity is greater; consequently the torpedo should deviate to the right. To compensate for this the forward propeller should have greater blade area than the after one, or, by formula, if:

A = area of forward propeller blades.

A' = area of after propeller blades.

P = pressure per unit area on blades at right angles to axis of torpedo when propellers are revolving.

R = distance of center of effort on forward blades from center of gravity.

x = distance between center of efforts of blades, then

$$P\,A\,R = P\,A'\,(R + x) \text{ or } A\,R = A'\,(R + x)$$

$$A = A'.\,\frac{R + x}{R}.$$

Using actual data from scale drawings we have:

$R = 78.25$ inches; $x = 2.25$ inches, hence

$$A = \frac{80.50}{78.25}.A' \text{ or } A = 1.03A'.$$

The area, therefore, of the forward propeller blades should be nearly three hundredths greater than that of the after ones.

As a matter of fact the chief object of the tandem propellers is to prevent the rolling, or counter-revolution, of the torpedo which would be caused by one propeller, so the propellers are turned out at the factory with as nearly equal blade areas as is mechanically possible; but at the trial station the rolling register is employed, and the ends of the blades filed off arbitrarily until rolling is eliminated. No consideration, then, can be given to their sluing effects; in fact if the forward blades chance to be the ones reduced to prevent rolling, the sluing effect will be aggravated. It is evident that the blade areas cannot be adjusted to compensate for *both* rolling and sluing effects, nor can the speed of propellers be differentiated to counteract one without aggravating the other evil. It would be better, therefore, to design or finish the propellers to equalize their sluing efforts, and correct the rolling effect by a greater metacentric height, or by an adjustment of ballast in trial runs.

The condition of the sea, the angle of train and the speed of the ship will affect the course of the torpedo by deflecting it as it enters the water. The deflection so caused is being studied by officers connected with the Torpedo Station, and should also be carefully studied by all who have an opportunity to handle the weapon afloat, especially the deflection produced on a torpedo fired abeam when the ship is running at her probable battle speed. Incomplete experiments so far indicate about 1° deflection per knot of speed.

Broaching, Running Deep, or Irregular Immersion.—From an above-water launching tube a torpedo takes an initial dive, and the depth of this dive will depend upon (a) the height from which the torpedo falls, (b) the angle at which it enters the water, (c) the angle at which the horizontal rudder is locked, (d) the length of time this rudder is locked, and (e) the density of the water. The angle of entry into the water depends upon (f) the depression of the tube, and (g) the weight of the impulse charge. A perfect dive should take the torpedo exactly to its adjusted plane of immersion, bring it to a horizontal position just as it reaches that plane, and leave it at that moment under automatic control. With practice this result can be quite closely attained, and the sure guide in diagnosing the behavior of the torpedo during its initial dive is the depth register card. The figures here given illustrate some faulty dives and suggest their causes and the remedies. The dotted curve in each figure indicates a perfect dive.

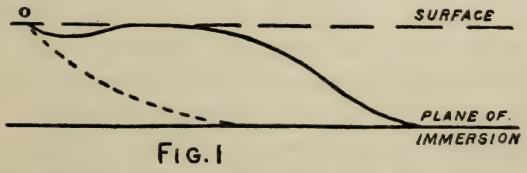


FIG. 1

FIG. 1.—Torpedo scarcely dives at all, then broaches, then seeks its depth automatically. Give the tube more depression, or, if the tube is fixed, decrease the impulse charge.

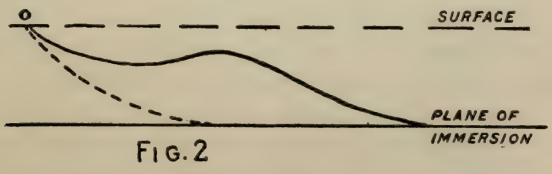


FIG. 2

FIG. 2.—Initial dive still insufficient, and a tendency to broach. There is too much up-rudder when locked. Reset it by the locking star, even making it a little down if necessary.

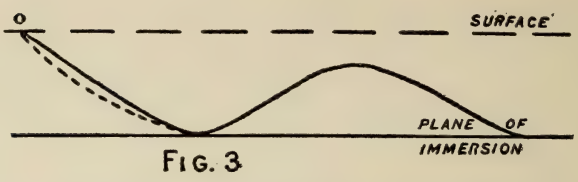


FIG. 3

FIG. 3.—Initial dive sufficient; followed, however, by a tendency to broach. The horizontal rudder was locked too long. Set the immobilizing gear a fewer number of teeth.

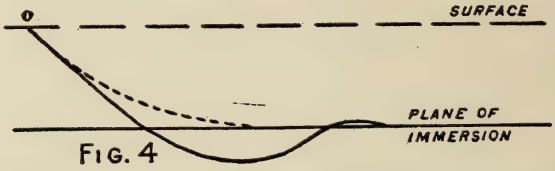


FIG. 4

FIG. 4.—Initial dive too great. Set the locking star so that the horizontal rudder will be locked a little more up, or give the tube less depression.

In these adjustments we are again confronted with the effect of the density of the water. In sea water (density 1.026) the torpedo, after its initial dive, has a tendency to bob up to the surface until the horizontal rudder is released and controls it. If the density of the water is less than 1.02, however, the torpedo has a tendency to keep on down while the rudder is locked, unless it is locked a little up. A broach in brackish or fresh water will only occur when the rudder is locked a little up and too long. A torpedo whose initial dive in sea water has been adjusted will, in fresh or nearly fresh water, take a dive such as is shown in Fig. 4, and must be readjusted for the new condition. In fact the dive is likely to be very deep and the torpedo may strike bottom.

A surface run indicates that the rudder has remained locked or partially so, or that the steering engine has jammed. In the first case there will be a rapid series of broaches, and in the latter a continuous surface run.

Broaching in smooth water does not affect the torpedo's course, but in rough water the deflection might be anything.

Torpedo runs away; i. e., runs until beached or until all air is exhausted. If it makes a surface run it is a sure sign that the pawls have failed to operate the ratchet wheel. If it is a run

below the surface and the rudder was properly locked and distance gear set, it is evident that the ratchet wheel has operated all right, but that the friction cams have slipped over each other. In the open sea or with a clean beach beyond the range, running away need cause no anxiety.

Dents such as a torpedo gets in ordinary handling are of little consequence. The head may be very much deformed and even the after body indented without any appreciable change in a torpedo's accuracy. Nevertheless, indentations should be beaten out with a copper maul having a rounded surface, using a wooden block on the outside of the shell as an anvil, hollowed to the shape of the injured surface.

The Whitehead torpedoes of latest pattern abroad are 16.5 feet long, have three-bladed propellers, make 31 knots, and have an extreme range of 1000 yards and a charge of 175 pounds of gun cotton. A similar type is now to be built in the United States. The omission of sinking gear in these new torpedoes is a step in the right direction, but other auxiliary gear could just as well be omitted or modified, and upon this subject I venture to make some suggestions.

1. If the spring of the hydrostatic piston were permanently set to balance it at a depth of eight feet below the surface, no depth index would be necessary, for at that depth a torpedo would hit the unprotected hull of any vessel worthy to be attacked. If the torpedo's plane of immersion varied three feet either way from that for which set, which is outside the limit of probability, there would be no loss of destructive effect. The gain would be one less adjustment to look after, one less possible leak in a very vital part, and the saving in cost and labor for several small, carefully finished parts.

2. I believe that the present distance gear and the locking gear could also be omitted. The initial dive can be controlled within sufficient limits by the depression of the tube or by varying the impulse charge, or by combining both methods.

3. It is mechanically possible so to construct the reducing valve that when flask pressure is down to engine pressure the regulator spring will push the controlling valve far enough up to open a permanent air connection to the top of the reducing valve and thereby to close it. Thus the regulator spring would become a distance regulator, and the torpedo would be stopped when the

air pressure in the flask had fallen to that at the engine; as should be the case, for the effective range of the torpedo is the distance over which a uniform and sufficient speed can be maintained. The course of a torpedo after that is no more to be relied upon than the ricochet of a shell. I believe this effective range to be, with our present Whitehead, about 600 yards, and I think our adjustment cards should be prepared for that range only, instead of for 400 and 800 yards.

4. The transportation screw, projecting as it does far beyond the shell, is in imminent danger of being broken short off during handling, thus disabling the torpedo until the broken shank can be drilled out of the shell and pendulum bob. Its use, moreover, is practically unnecessary; in fact I have seen torpedoes handled, even to turning them upside down, at the Torpedo Station and at the Bliss Company's proving station, without using the transportation screw at all. The transportation screw may, therefore, be discarded. There is none used in the Howell, yet it has two pendulums instead of one.

5. The present elevating gear for between-deck broadside launching tubes, such as is installed in many of our men-of-war, is an abomination, as it takes from five to ten minutes and the labor of two men, turn and turn about, to depress the tube five degrees. A tube cannot always be laid at its approximate depression before loading the torpedo into it, because it has often to be nearly level in order to receive the torpedo from the trolley. Moreover, in battle it may happen that water-line punishment will give the ship a list of several degrees, and the depression of the tube would have to be quickly changed to counteract this. The old differential elevating screw fitted to our VIII-inch muzzle-loading guns is what we want for torpedo tubes.

6. The loading tray for a launching tube is a clumsy and useless contrivance and should be abolished.

7. The doors of launching tubes should swing through at least 180°, for as at present fitted, swinging only about 90°, they mask the orifice for reaching the valve star and locking star of the horizontal rudder, so that these cannot be adjusted, or their adjustments verified, while charging a torpedo in the tube.

THE HOWELL TORPEDO.

The preliminary remarks about assembling the Whitehead are equally applicable to the Howell. If it is already assembled it should be taken apart and inspected, for parts may be found tied with twine, gaskets may be found worn out or hardened, and the after section may be found so shipped that the propeller shafts are not entered in their sockets. Such was the condition of one Howell as I found it assembled. When the after section of the Howell is separated from the middle section, care must be taken *not to turn one propeller independently of the other*, for the eccentric shaft is geared to both propeller shafts by worm wheels which may be broken if one is forced to turn while the other is stationary.

The use of a heaver in the calcium phosphide or depth register pockets *must be absolutely prohibited.* It is a great temptation to a blue-jacket to ship a handspike in one of these pockets in sluing the torpedo for any purpose, especially when connecting up the head by the bayonet joint, and if the solder of these pockets is broken the torpedo will be flooded during its run.

The rod carrying the balance weights in the exercise head should be taken out, and the distance of the weights from one end of the rod measured and recorded. The number of threads to the inch on this rod should also be measured and recorded, so that alteration of trim can be made systematically.

An index, similar to the depth index of the Whitehead, might be fitted over the forward end of this rod to show the longitudinal position of the balance weights at any time. It may well be remarked here, however, that the Howell torpedo may be considerably out of trim by the head, either up or down, without seriously affecting its run.

Use of Locking Gear.

The locking gear of the Howell must certainly be used when firing from the bow tube of a vessel under way, for the speed of the vessel plus the speed of discharge is greater than the speed of the torpedo in the water, and the consequent retardation causes the pendulum to swing forward for an appreciable length of time, giving up-rudder and sometimes causing the torpedo to broach. Under other conditions the speed in air and water are about the

same, the retarding is but momentary, and neglect to use the locking gear will generally be of no consequence. The abolition of bow tubes, and increased speed for new Howells, may make locking gear wholly unnecessary.

Effect of the Density of the Water.

The density of the water more seriously affects Howell torpedo exercise than Whitehead. Our present service Howell, ready for an exercise run, weighs 510 pounds and has a reserve buoyancy in sea water (specific gravity 1.026) of ten pounds. A simple calculation will show that this torpedo is not buoyant in water whose specific gravity is less than 1.012. I weighed two Howells in water of specific gravity 1.005 and they weighed four pounds each, which agreed exactly with their weight by calculation. When hoisted out of the water they were found perfectly dry inside. In water absolutely fresh the Howell will weigh about 5 pounds. If, therefore, a Howell is fired in water whose specific gravity is less than 1.012, it will sink at the end of its run and may be lost. This limits safe exercise with this torpedo to seaboard waters, unless some scheme is devised which will make it more buoyant. My first expedient to this end was to use the water space in the exercise head as a buoyancy chamber, filling the regular buoyancy chamber with water and running the balance weights as far forward as possible, but the torpedo could not be trimmed, even with additional weights on the nose, and floated vertically, nose up. I would therefore suggest that a wooden disc of sufficient size to give the buoyancy desired be placed in the exercise head. A disc of seasoned pine 11 inches in diameter, 9 inches long and with an axial hole large enough to allow the block to slip over the casing of the trimming weights, would make the torpedo buoyant in fresh water. I believe that the trim can then be readjusted with the sliding weights alone.

Notwithstanding its lack of buoyancy, the Howell can be recovered after an exercise run in fresh or brackish water if it is trimmed tail heavy, by recapturing it before it has entirely run down. The propellers keep its nose bobbing to the surface at the end of the range as long as they revolve. This method, however, is too risky to be recommended.

Howell torpedo tubes thus far installed in our vessels have been almost all fixed bow tubes, and it is intended that they

should have a permanent depression of 3°. When there are but few stores on board, however, this depression almost disappears. I have been compelled to use a bow tube at ¾° elevation. The first torpedo thus fired was discharged with the usual 6 oz. of cubical black powder. It was badly ejected, swung downward at a great angle and dove almost perpendicularly to the bottom (18 feet). Then I increased the charge to 8 oz. and obtained a perfect dive.

It is very important to note, when steam is first turned on the motor, the direction in which the propellers of the Howell revolve. The upper blades should turn toward each other, yet it is possible to assemble the Dow motor in such a manner that it will drive the flywheel backwards and make the torpedo run astern when launched. Such a blunder was made on the practice vessel Bancroft at the U. S. Naval Academy, and the result is worth describing:

Serious leaks in the steam pipes leading to the Dow motor on that vessel were discovered in exercise. When the engineer's force repaired the leaks they took the motor to pieces, presumably to learn something about it. The driving discs of the motor were marked " R " and " L," and the casing was similarly marked, *but these shop marks were wrong* and the motor had not been originally assembled by them. Not noting this, however, and being wholly unfamiliar with the machine, the men employed upon it reassembled it according to the marks, thus reversing the driving discs. Now, although this change throws the ports in both fixed and driving discs into the same general alignment, this alignment has a spiral trend, enough to produce rotation in the opposite direction to that originally intended.

Preparations to fire were made some days after this. The speed ran up slowly, but this was attributed to long leads and reduced boiler pressure. The possibility that the motor had been assembled wrong was naturally not suspected, and if it had been it is probable that the drill officer would have dismissed the suspicion when the motor revolved at all, for he might reasonably have regarded its rotation impossible with driving discs reversed.

As the delay in getting full speed was holding back a great-gun target practice, it was determined to fire with 6000 revolutions. The torpedo dove very prettily, then came to the surface tail foremost almost precisely where it went down, and fell flat upon

the water with its tail slued to starboad. It gathered sternboard quickly and circled rapidly to starboard tail foremost in a circle about equal in radius to the weapon's length, having an undulating motion, approaching and receding from the surface at an average depth of about four feet (for which it was set). After three or four complete turns it gradually settled to the bottom, still circling as long as visible. The spot was buoyed, and after nine days of unremitting effort, during which oyster rakes, grapnels and drag nets were used, the torpedo was recovered, near the spot where lost, by a fisherman with a bent iron rod on the end of a clothes line. He hooked it through the tail frame. The following injuries were then noted:

1. The middle and after sections had nearly half filled with water which had gradually seeped in during nine days, for this water did not leak out at all when the torpedo was landed on the dock and turned over and over.

2. The depth register pocket was full of water, the main spring of the depth register clockwork destroyed by corrosion, and the curve on the card obliterated.

3. The pitch trigger had operated during the initial dive, allowing the reverse motion of the cam gear to break and bruise several teeth in the gear wheels, for the pitch cam was set back to the end of its slot before discharge. The trigger, however, had been thrown up again as the torpedo backed to the surface, and remained so.

4. The port worm wheel on the eccentric shaft had been torn from its hub.

5. All steel parts outside the shell were so eaten away by galvanic action that another nine days' immersion might have ruined them.

One serious drawback to exercise with the Howell is its lack of distance gear. It can only be recovered upon running down, after an interval of 1½ to 3½ minutes from the moment of discharge. During 45 seconds of this time it is quite rigidly on its course in the line of fire, but during the remaining time it may be swept far from the point where it is expected to bring up, and, unless its probable direction is shrewdly guessed, it may be lost. With a moderate breeze and in bright sunlight the phosphide gives but a faint and spasmodic flicker, almost unnoticeable be-

yond one hundred yards from the search boat. When the torpedo loses its rigidity it generally deviates to the left, and its extreme range to a full stop is about 850 yards. The method suggested for plotting Whitehead target practice at sea would, therefore, be of no value for the Howell. Remembering this distance and deviation, and also that if you can lie to leeward of the Howell's course the smell of the phosphide will probably lead you to it, you are somewhat guided in your preparations for recovery. There are four ways of fitting distance gear which seem to be mechanically possible:

1. Cam gear which will produce zero pitch of propeller blades at the desired time in the run.

2. Cam gear to give infinite pitch. This would bring the greatest resistance of the water on the blades and shorten the spin of the flywheel.

3. A device to release the blades from control in their sockets at the end of the desired range, and allow them to pivot into the position of least resistance.

4. Automatic sliding couplings on the propeller shafts to uncouple at the end of the desired run.

Of these I believe the third would be the simplest, and it would add nothing to the load on the flywheel during the run.

Suggested Modifications in the Howell.

The screw fan on the exercise nose is an unnecessary attachment.

The slotted bulkhead nuts with screw-driver wrenches are awkward and vexatious to set up and should be replaced by hexagonal nuts and socket wrenches.

A manifolding oil pot should be located over the many oilways of the immersion regulating gear, with feeders to each of them. It could be filled through a filling hole in the top of the shell, closed by a tap screw, and thus much time would be saved in oiling and no bearing could be overlooked.

A larger number of spare parts should be furnished, and especially a spare set of propeller blades, for these are easily and almost always curled up or broken if the torpedo grounds.

Although the effective range of the present Howell is only claimed to be 400 yards, trials at Tiverton have shown it to make repeated 600 yard runs at an average speed of 19.5 knots, with a

mean lateral error of 6 yards and at set depth. For the sake of uniformity, therefore, the effective range of both the Whitehead and Howell torpedoes now in our service may be set down as 600 yards; remembering that the Whitehead will cover that distance in 40 seconds, and the Howell in one minute.

BATTLE PRACTICE.

Practice with torpedoes having exercise heads is not sufficient to insure their effective use in battle, and it is imperative that commanders be instructed to expend at least one torpedo of each kind a year, with war head attached, against a target which will demonstrate its destructive efficiency. For the purpose of stimulating proficiency and forecasting the yearly expenditure, it might be made a regulation that every ship which, after adequate target practice, lost no torpedoes during a year, should expend one torpedo with war head attached under the nearest possible approximation to battle conditions. Derelicts, hulks and condemned vessels should be the targets used. Such practice might cost in the aggregate $100,000 a year, but until it is allowed, a torpedo officer is like the small boy who has permission to swim but is forbidden to go near the water.

Every officer who has studied torpedoes should give his views upon their use in battle, for there will be nothing better than a concensus of opinion to guide us until war comes. Some important questions which should be decided are: How should the torpedoes be installed? by whom should their discharge be controlled, and when should they be used against the enemy in a fleet engagement?

Installment.

I am convinced, from a careful study of the tactical game and tactical situation at the War College, and from the statements of thoughtful writers upon the subject, that ships are not going to fight bows on, but broadside to broadside, and that if a ship's bow is turned toward the enemy within torpedo range of him it is her commander's purpose either to charge through the line or to ram. If it is his intention to charge through, he will bring no vessel in line with his bow torpedo, and if he is endeavoring to ram he risks self-destruction if he is unable, through any of the manifold mischances, to eject his bow torpedo before collision.

A man who attempts to beat another man over the head with the butt of a loaded revolver is committing a folly which may cost him his own life. No warship likely to take her place in the line of battle should have bow torpedo tubes. Broadsides pivot-tubes alone should be fitted, say two on each side. Stern tubes are scarcely worth their space and cost of installment, for a torpedo discharged into the race of a ship's propellers is a mere hazard.

If a torpedo room has no armor protection the torpedoes in it or in the tubes are, in battle, a constant menace to the ship carrying them. An air flask exploded by a shell would probably kill every man in the compartment and wreck all installation, and might even detonate the war head (although I think this unlikely) and destroy the ship. A shell exploding in the war head or a fragment striking the detonator would undoubtedly do so. To carry eight or ten such weapons into battle in unprotected compartments with the merely possible chance of using them is to invite destruction. Torpedo rooms in battle-ships or armored cruisers should be as heavily protected by armor as the most important gun positions. It would be still better if they could be below the water line, under the protective deck, with under-water discharge tubes. We have too long shirked the problem of the under-water discharge, and should take it up at once with a determination to solve it. European nations claim that they have successfully done so.

Control of Fire.

The torpedo is a weapon of opportunity. It must be used when the enemy is within a certain range and on a certain line of bearing. The captain should not be burdened with the collateral duty of watching for this opportunity. An officer should be stationed in a position on deck where he could watch the enemy's vessels and judge by their movements and those of his own vessel when the opportunity was likely to occur. He should be in communication with the torpedo rooms by voice tubes and electric bells or indicators, and should have a torpedo director. He should signal down the angle of train and should be kept informed from the torpedo rooms of the readiness to fire. He should keep himself informed of the speed of his own vessel and should make signal to fire at the proper moment without advice

or suggestion from others, and his signal should be instantly obeyed below. If any delay must follow his signal, the torpedo should not be fired, and he should be immediately informed of the reason why. He need only inform the captain of the result of a successful shot or that he has expended all of his torpedoes. His position might necessarily be an exposed one, yet it is quite possible to place him in an inconspicuous tower which would save him from being an unmistakable target within torpedo range and give him a certain sense of security which would be conducive to coolness and good judgment.

On scout vessels, unprotected cruisers and gunboats, torpedo rooms cannot be protected, and it might be argued that these vessels should not be equipped with torpedoes, but such is not my idea. Equip them, like battle-ships, with broadside tubes. When the duty of such a vessel is scouting and keeping touch with the enemy without becoming engaged, the war heads should be kept below the protective deck without primers and the flasks uncharged, for the torpedoes are then of no use. In the pursuit of merchant vessels or when harassing a convoy there may often come a time when a cruiser has but a few moments in which to strike a destructive blow. At such a time a torpedo will accomplish in thirty seconds what fire or guns could only do in several hours, and would not, like these latter, so widely advertise the presence of the destroyer. When the cruiser is brought to bay by a superior force, every preparation should be promptly made to use her torpedoes, and her chief endeavor should be to get within torpedo range and use them, for she is then in a desperate situation, when a desperate measure alone can achieve her salvation. In this connection it is well to realize how much quicker a war head can be secured on a Howell by its bayonet joint than on a Whitehead by its multitude of joint screws. In specifications for new Whiteheads it would be well to require bayonet joint connections for war and exercise heads.

To be properly prepared for war we should have on hand a large reserve supply of torpedoes. We have, so far, less than 200 Whiteheads and 100 Howells, and of these some few have been expended in exercise. The Hotchkiss Ordnance Company claims that it could turn out at an emergency rate about fifteen Howell torpedoes a month, and the Bliss Company could probably do about the same with the Whiteheads. This would be in-

sufficient, but, what is far worse, there would be no time for trials and inspections, so that perhaps half the weapons would be worthless. We rely upon assembling vast mosquito fleets in a war emergency, a large proportion to be torpedo-boats, but of what use would they be without torpedoes? The British Government has on hand to-day more than three thousand automobile torpedoes, while we, who must still look to the torpedo to make up our great deficiency in other means of coast defence, have scarcely enough to equip our present sea-going navy.

TORPEDO BOATS AND DRILL GROUNDS.

Statements are being made in the public prints that it is contemplated to select a site for a depot where our torpedo flotilla may be kept in ordinary, equipped, repaired and exercised; and two places have been mentioned as under consideration, viz: Boston and Newport. That we shall soon need such a depot is very true, but let us select the site absolutely on its merits. The following considerations, and perhaps others, should enter into the selection:

1. The depot should be centrally located in the probable theater of defensive operations.

2. It should rest upon the chain of interior waterways which parallels our Atlantic Coast.

3. It should be near a body of water suited for torpedo boat drill and torpedo exercise.

4. It should have communication by interior commercial routes with torpedo and explosive manufactories and sources of general supply.

5. It should be beyond the reach of a hostile raid from the sea.

6. It should possess the tactical advantage of various outlets for sorties, or, in a last extremity, for escape and retreat to other bases.

7. Its approaches should be capable of complete protective surveillance and strong defence.

Of these seven conditions Boston fails to satisfy all but the 4th, and Newport meets only the 1st, 3d and 4th. The advantage lies with Newport, which still falls short of more than half the requirements. The proper solution of the problem lies in working from the requirements to the selection.

The probable theater of defensive operations is our Atlantic coast from Penobscot to Chesapeake Bay. Conditions 1 and 2 must, therefore, be satisfied somewhere between Nantucket and New York. Condition 3 throws the balance of favor toward Long Island Sound. Condition 5 retires us into Little or Great Peconic Bay. Here we will find conditions 6 and 7, with a little artificial work, admirably satisfied, and it only remains to find a site on these bays which will satisfy condition 4. Following out the railroads of Long Island brings us to Jamesport and New Suffolk; both good sites, but the former unnecessarily retired.

New Suffolk is, then, to my mind, an ideal site for a torpedo arsenal. In the basin between the town, Little Hog Neck and Robbins' Island a hundred torpedo-boats could lie secure in all weathers. Along the stretch of beach from the town to the Neck there is room for as many marine railways as may be desired, backed with gently sloping ground for shop sites. Robbins' Island, right at hand and now only used by a gun club, would afford an excellent depot for explosives. The Long Island Railroad, which now passes at Cutchoug, 2½ miles from New Suffolk, would quickly build a branch to the latter place if an arsenal were established there, thus giving short and direct communication with the Bliss (Whitehead) torpedo works in Brooklyn and with all sources of supply through New York. Howell torpedoes could be transported from Providence *via* New London and across the Sound by regular commercial routes, or brought by water direct from the manufactory.

A hostile force seeking the New Suffolk depot would have to pass first through Gardiner's Bay, a place which would almost surely be held by our fleet, and thence through the narrow and tortuous channels around Shelter Island, which are capable of the strongest defence. If necessary, our torpedo flotilla could retire behind Robbins' Island, gaining a second line of defence as strong as the outer one. The flotilla would not even then be in a *cul de sac*, for Shinnecock Canal connects Great Peconic Bay with Shinnecock Bay, and will in a few months connect the latter with the Atlantic Ocean, while further cuts now existing at Quog and to the westward would, with some improvement, give an interior waterway along the whole south side of Long Island to New York. These various canals are under the supervision of the New York State Engineers and, along with the Erie Canal,

are now being improved under a liberal appropriation. They are all actually existing cuts to-day, only lacking from one to three feet in depth for torpedo-boat navigation. The Shinnecock and Quog Canals will be thus deepened within a year.

Jamesport and Riverhead lie at the head of Great Peconic Bay as bases of supply on the same line of communications with New Suffolk, if the flotilla is cut off from the latter place.

Gardiner's and the Peconic Bays form an ideal sheet of water for all torpedo-boat exercises. Enormous mosquito fleets can be manoeuvered, strategic exercises by night and day carried out, and torpedo target practice conducted on the most comprehensive scale. Operations in connection with the main fleet can be carried on without constriction. Perfect anchorages for small craft abound, such as Orient Harbor, Deerings Harbor, Noyack Bay, New Suffolk and the Peconic River. Excellent markets will be found at Sag Harbor and Greenport, only three hours by rail from New York. The Bliss Company's regular Whitehead proving ground is now Noyack Bay.

Certain improvements should be made in connection with the choice of New Suffolk as a torpedo arsenal. I shall not dwell upon the deepening of the canals mentioned, for that is already being done by the New York State Engineers; nevertheless there should be an *entente* with them in order that their work shall fully satisfy the needs of the proposed arsenal. Orient Harbor and Long Island Sound should be connected by a cutting at " Dam Pond " (also locally known as " Mud Pond "), two miles west of Orient Village, where nothing but a parapet of cobbles eighty feet wide and ten feet high now separates these waters. An interior route into Long Island Sound would thus be obtained, so that torpedo-boats could enter the Sound from the Peconic Bay district without passing out into Gardiner's Bay. Finally, the creek behind Ram Head could be utilized as a place of concealment for torpedo-boats before a sortie, or as an impregnable harbor of refuge, if its entrance were deepened one foot and the sand-spit connecting Ram Head to Shelter Island were cut through.

It is true that the Peconic system will be frozen during at least three months of the year, but so will any other available place fulfilling a majority of the requirements. It may be well to have a second depot and drill ground for winter work and a rendezvous should we have to fight in winter, somewhere near or

south of Norfolk, but to discuss that now would be attempting to cross a bridge which is still a long way off.

A certain percentage of our coming torpedo flotilla should be kept constantly in commission, and, for officers so employed, duty on torpedo-boats should count as a cruise, for no labor afloat will be more arduous than theirs. Command of torpedo-boats should be given to officers whose next subsequent sea duty would be as navigators, for such duty will be an excellent school of instruction in navigating our home waters. Officers and crews should shift from one boat to another at regular periods in order that every torpedo-boat in the service might be kept up to cruising efficiency. From April to November a regular program of exercise should be carried out, such as the following:

April and May.—Torpedo target practice under way in Great and Little Peconic Bays, endeavoring to extend the exercise to all boats at the station and to use all their torpedoes.

June.—Night attacks upon vessels of the fleet in various harbors by all torpedo-boats regularly in commission during that month. Similar attacks in foggy weather and under other favorable conditions which might present themselves.

July.—Operations in conjunction with the regular battle fleet manoeuvers; additional torpedo-boats being then commissioned if necessary to bring the torpedo fleet up to at least one for every vessel in the main fleet.

August.—The whole torpedo flotilla commissioned, drawing from the naval militia and officers on shore duty. Mosquito fleet tactics in Gardiner's Bay and the Peconic Bays, with torpedo target practice in fleet formations. This month's work to be directed by the War College with a view to solving tactical problems and even hypothetical strategic situations embracing a large theater of coast operations, by dividing the fleet into opposing squadrons having artificial battle fleet values.

September.—Completion of any unfinished work of previous programs. Summer fleet to go out of commission.

October.—Reconnoissance of harbors, bays and interior waterways with a view to developing plans of defence and preparing war charts. This work to be directed by the War College and performed by those boats kept regularly in commission.

November.—Boats needed for winter manoeuvers to go south and join the main fleet at its rendezvous.

We have the torpedoes and we are building the torpedo-boats. Shall they be as the pound kept laid up in a napkin? They come to us from the inventors and builders only as ingenious and costly mechanical toys, and we are tempted to cast them aside after some passing curiosity because we blunder with them in the first handling; but let us all realize, from the Secretary of the Navy down to the youngest apprentice who handles the torpedoes or serves on the boats, that it rests entirely with ourselves, by constant practice, to make them efficient, destructive weapons and vessels of war.

(*Discussion at end of number.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

WASHINGTON'S FORGOTTEN MAXIM.*

Address of Hon. THEODORE ROOSEVELT,

Assistant Secretary of the Navy, before the Class at the U. S. Naval War College, Newport, R. I., June 2d, 1897.

A century has passed since Washington wrote "To be prepared for war is the most effectual means to preserve peace." We pay to this maxim the lip-loyalty we so often pay to Washington's words; but it has never sunk deep into our hearts. Indeed, of late years many persons have refused it even the poor tribute of lip-loyalty, and prate about the iniquity of war as if somehow that was a justification for refusing to take the steps which alone can, in the long run, prevent war or avert the dreadful disasters it brings in its train. The truth of the maxim is so obvious to every man of really far-sighted patriotism that its mere statement seems trite and useless; and it is not over-creditable to either our intelligence or our love of country that there should be, as there is, need to dwell upon and amplify such a truism.

In this country there is not the slightest danger of an over-development of warlike spirit, and there never has been any such danger. In all our history there has never been a time when preparedness for war was any menace to peace. On the contrary, again and again we have owed peace to the fact that we were prepared for war; and in the only contest which we have had with a European power since the Revolution, the War of 1812, the struggle, and all its attendant disasters, were due solely to the

* "To be prepared for war is one of the most effectual means of preserving peace."—Washington's speech to both Houses of Congress, Jany. 8th, 1790.—*Editor.*

fact that we were not prepared to face, and were not ready instantly to resent, an attack upon our honor and interest; while the glorious triumphs at sea which redeemed that war were due to the few preparations which we had actually made. We are a great peaceful nation; a nation of merchants and manufacturers, of farmers and mechanics; a nation of workingmen, who labor incessantly with head or hand. It is idle to talk of such a nation ever being led into a course of wanton aggression or needless conflict with military powers by the possession of a sufficient navy.

The danger is of precisely the opposite character. If we forget that in the last resort we can only secure peace by being ready and willing to fight for it, we may some day have bitter cause to realize that a rich nation which is slothful, timid or unwieldy is an easy prey for any people which still retains those most valuable of all qualities, the soldierly virtues. We but keep to the traditions of Washington, to the traditions of all the great Americans who struggled for the real greatness of America, when we strive to build up those fighting qualities for the lack of which in a nation, as in an individual, no refinement, no culture, no wealth, no material prosperity, can atone.

Preparation for war is the surest guarantee for peace. Arbitration is an excellent thing, but ultimately those who wish to see this country at peace with foreign nations will be wise if they place reliance upon a first-class fleet of first-class battle-ships, rather than on any arbitration treaty which the wit of man can devise. Nelson said that the British fleet was the best negotiator in Europe, and there was much truth in the saying. Moreover, while we are sincere and earnest in our advocacy of peace, we must not forget that an ignoble peace is worse than any war. We should engrave in our legislative halls those splendid lines of Lowell:

> "Come, Peace! not like a mourner bowed
> For honor lost and dear ones wasted,
> But proud, to meet a people proud,
> With eyes that tell o' triumph tasted!"

Peace is a goddess only when she comes with sword girt on thigh. The ship of state can be steered safely only when it is always possible to bring her against any foe with "her leashed thunders gathering for the leap." A really great people, proud

and high-spirited, would face all the disasters of war rather than purchase that base prosperity which is bought at the price of national honor. All the great masterful races have been fighting races, and the minute that a race loses the hard-fighting virtues, then, no matter what else it may retain, no matter how skilled in commerce and finance, in science or art, it has lost its proud right to stand as the equal of the best. Cowardice in a race, as in an individual, is the unpardonable sin; and a wilful failure to prepare for danger may, in its effects, be as bad as cowardice. The timid man who cannot fight, and the selfish, short-sighted or foolish man who will not take the steps that will enable him to fight, stand on almost the same plane.

It is not only true that a peace may be so ignoble and degrading as to be worse than any war; it is also true that it may be fraught with more bloodshed than most wars. Of this there has been melancholy proof during the last two years. Thanks largely to the very unhealthy influence of the men whose business it is to speculate in the money market, and who approach every subject from the financial standpoint purely; and thanks quite as much to the cold-blooded brutality and calculating timidity of many European rulers and statesmen, the peace of Europe has been preserved, while the Turk has been allowed to butcher the Armenians with hideous and unmentionable barbarity, and has actually been helped to keep Crete in slavery. War has been averted at the cost of more bloodshed, and infinitely more suffering and degradation to wretched women and children, than have occurred in any European struggle since the days of Waterloo. No war of recent years, no matter how wanton, has been so productive of horrible misery as the peace which the powers have maintained during the continuance of the Armenian butcheries. The men who would preach this peace, and indeed the men who have preached universal peace in terms that have prepared the way for such a peace as this, have inflicted a wrong on humanity greater than could be inflicted by the most reckless and war-loving despot. Better a thousand times err on the side of over-readiness to fight than to err on the side of tame submission to injury or cold-blooded indifference to the misery of the oppressed.

Popular sentiment is just when it selects as popular heroes the men who have led in the struggle against malice domestic or foreign levy. No triumph of peace is quite so great as the

supreme triumphs of war. The courage of the soldier, the courage of the statesman who has to meet storms which can be quelled only by soldierly qualities, this stands higher than any quality called out merely in time of peace. It is by no means necessary that we should have war to develop soldierly attributes and soldierly qualities; but if the peace we enjoy is of such a kind that it causes their loss, then it is far too dearly purchased, no matter what its attendant benefits may be. It may be that some time in the dim future of the race the need for war will vanish; but that time is yet ages distant. As yet no nation can hold its place in the world or can do any work really worth doing unless it stands ready to guard its rights with an armed hand. That orderly liberty which is both the foundation and the cap-stone of our civilization can be gained and kept only by men who are willing to fight for an ideal; who hold high the love of honor, love of faith, love of flag, and love of country. It is true that no nation can be really great unless it is great in peace, industry, integrity, honesty. Skilled intelligence in civic affairs and industrial enterprises alike; the special ability of the artist, the man of letters, the man of science and the man of business; the rigid determination to wrong no man and to stand for righteousness, all these are necessary in a great nation. But it is also necessary that the nation should have physical no less than moral courage; the capacity to do and dare and die at need, and that grim and steadfast resolution which alone will carry a great people through a great peril. The occasion may come at any instant when

> "'Tis man's perdition to be safe
> When for the truth he ought to die."

All great nations have shown these qualities. The Dutch held but a little corner of Europe. Their industry, thrift and enterprise in the pursuits of peace, their cultivation of the arts, helped to render them great; but these qualities would have been barren had they not been backed by those sterner qualities which rendered them able to wrest their freedom from the cruel strength of Spain and to guard it against the banded might of England and of France. The merchants and the artists of Holland did much for her; but even more was done by the famished burghers who fought to the death on the walls of Harlem and Leyden, and the great admirals who led their fleets to victory on the broad and narrow seas.

England's history is rich in splendid names and splendid deeds. Her literature is even greater than that of Greece. In commerce she has stood in the modern world as more than ever Carthage was when civilization clustered in a fringe around the Mediterranean. But she has risen far higher than ever Greece or Carthage rose, because she possesses also the great masterful qualities which were possessed by the Romans who overthrew them both. England has been fertile in soldiers and administrators; in men who triumphed by sea and by land; in adventurers and explorers who won for her the world's waste spaces; and it is because of this that the English-speaking race now shares with the Slav the fate of the coming years.

We of the United States have passed most of our few years of national life in peace. We honor the architects of our wonderful material prosperity; we appreciate the necessity of thrift, energy and business enterprise; and we know that even these are of no avail without the civic and social virtues. But we feel, after all, that the men who have dared greatly in war, or the work which is akin to war, are those who deserve best of the country. The men of Bunker Hill and Trenton, Saratoga and Yorktown, the men of New Orleans and Mobile Bay, Gettysburg and Appomattox, are those to whom we owe most. None of our heroes of peace, save a few great constructive statesmen, can rank with our heroes of war. The Americans who stand highest on the list of the world's worthies are Washington, who fought to found the country which he afterwards governed, and Lincoln, who saved it through the blood of the best and bravest in the land; Washington, the soldier and the statesman, the man of cool head, dauntless heart and iron will, the greatest of good men, and the best of great men; and Lincoln, sad, patient, kindly Lincoln, who for four years toiled and suffered for the people, and when his work was done laid down his life that the flag which had been rent asunder might once more be made whole and without a seam.

It is on men such as these, and not on the advocates of peace at any price, or upon those so short-sighted that they refuse to take into account the possibility of war, that we must rely in every crisis which deeply touches the true greatness and true honor of the republic. The United States have never once in the course of their history suffered harm because of preparation for war or because of entering into war. But we have suffered incalculable

harm again and again from a foolish failure to prepare for war or from reluctance to fight when to fight was proper. The men who to-day protest against a navy, and protest also against every movement to carry out the traditional policy of the country in foreign affairs, and to uphold the honor of the flag, are themselves but following in the course of those who protested against the acquisition of the Great West and who failed to make proper preparations for the War of 1812, or refused to support it after it had been made. They are own brothers to the men whose short-sightedness and supine indifference prevented any reorganization of the *personnel* of the navy during the middle of the century, so that we entered upon the Civil War with captains seventy years old. They are as close kin to the men who, when the Southern States seceded, wished to let the Union be disrupted in peace rather than restored through the grim agony of armed conflict.

I do not believe that any considerable number of our citizens are stamped with this timid lack of patriotism. There are some doctrinaires whose eyes are so firmly fixed on the golden vision of universal peace that they cannot see the grim facts of real life until they stumble over them to their own hurt, and, what is much worse, to the possible undoing of their fellows. There are some educated men in whom education merely serves to soften the fiber and to eliminate the higher, sterner qualities which tell for national greatness; and these men prate about love for mankind, or for another country, as being in some hidden way a substitute for love of their own country. What is of more weight, there are not a few men of means who have made the till their fatherland, and who are always ready to balance a temporary interruption of money-making, or a temporary financial and commercial disaster, against the self-sacrifice necessary in upholding the honor of the nation and the glory of the flag.

But, after all, these people, though often noisy, form but a small minority of the whole. They would be swept like chaff before the gust of popular fury which would surely come if ever the nation really saw and felt a danger or an insult. The real trouble is that in such case this gust of popular fury would come too late. Unreadiness for war is merely rendered more disastrous by readiness to bluster; to talk defiance and advocate a vigorous policy in words, while refusing to back up these words by deeds, is cause for humiliation. It has always been true, and in this age

it is more than ever true, that it is too late to prepare for war when the time of peace has passed. The short-sightedness of many people, the good-humored indifference to facts of others, the sheer ignorance of a vast number, and the selfish reluctance to insure against future danger by present sacrifice among yet others —these are the chief obstacles in the way of building up a proper navy and carrying out a proper foreign policy.

The men who opposed the War of 1812 and preferred to have the nation humiliated by unresented insult from a foreign power rather than see her suffer the losses of an honorable conflict, occupied a position little short of contemptible; but it was not much worse than that of the men who brought on the war and yet deliberately refused to make the preparations necessary to carry it to a successful conclusion. The visionary schemes for defending the country by gunboats instead of by a fleet of sea-going battle-ships, the refusal to increase the navy to a proper size, the determination to place reliance upon militia instead of upon regularly trained troops, and the disasters which followed upon each and every one of these determinations, should be studied in every school-book in the land so as to enforce in the minds of all our citizens the truth of Washington's adage that in time of peace it is necessary to prepare for war.

All this applied in 1812; but it applies with ten-fold greater force now. Then, as now, it was the navy upon which the country had to depend in the event of war with a foreign power; and then, as now, one of the chief tasks of a wise and far-seeing statesmanship should have been the upbuilding of a formidable fighting navy. In 1812 untold evils followed from the failure to provide such a fighting navy, for the splendid feats of our few cruisers merely showed what could have been done if we had had a great fleet of battle-ships. But ships, guns and men were much more easily provided in time of emergency at the beginning of this century than at the end. It takes months to build guns and ships now, where it took days or, at the most, weeks then; and it takes far longer now to train men to the management of the vast and complicated engines with which war is waged. Therefore, preparation is much more difficult and requires a much longer time; and yet wars are so much quicker, they last so comparatively short a period, and can be begun so instantaneously that there is very much less time than there was formerly in which to make preparations.

No battle-ship can be built inside of two years under no matter what stress of circumstances, for we have not in this country the plant to enable us to work faster. Cruisers would take almost as long. Even torpedo-boats, the smallest of all, could not be put in first-class form under ninety days. Guns available for use against a hostile invader would require two or three months; and in the case of the larger guns, the only ones really available for the actual shock of battle could not be made under eight months. Rifles and military munitions of every kind would require a corresponding length of time for preparation; in most cases we should have to build, not merely the weapons we need, but the plant with which to make them in any large quantity. Even if the enemy did not interfere with our efforts, which they undoubtedly would, it would therefore take from three to six months after the outbreak of a war, for which we are unprepared, before we could in the slightest degree remedy our unreadiness. During these six months it would be impossible to over-estimate the damage that could be done by a resolute and powerful antagonist. Even at the end of that time we would only be beginning to prepare to parry his attack, for it would be two years before we could attempt to return it. Since the change in military conditions in modern times there has never been an instance in which a war between any two nations has lasted more than about two years. In most recent wars the operations of the first ninety days have decided the result of the conflict. All that followed has been a mere vain effort to strive against the stars in their courses by doing at the twelfth hour what it was useless to do after the eleventh.

We must therefore make up our minds once for all to the fact that it is too late to make ready for war when the fight has once begun. The preparation must come before that. In the case of the Civil War none of these conditions applied. In 1861 we had a good fleet and the Southern Confederacy had not a ship. We were able to blockade the southern ports at once, and we could improvise engines of war more than sufficient to put against those of an enemy who also had to improvise them, and who labored under even more serious disadvantages. The Monitor was got ready in the nick of time to meet the Merrimac, because the Confederates had to plan and build the latter while we were planning and building the former; but if ever we have to go to

war with a modern military power we shall find its Merrimacs already built, and it will then be altogether too late to try to build Monitors to meet them.

If this point needs any emphasis surely the history of the War of 1812 applies to it. For twelve years before that war broke out even the blindest could see that we were almost certain to be drawn into hostilities with one or the other of the pair of combatants whose battle-royal ended at Waterloo. Yet we made not the slightest preparation for war. The authorities at Washington contented themselves with trying to build a flotilla of gunboats which could defend our own harbors without making it necessary to take the offensive ourselves. We already possessed a dozen first-class cruisers, but not a battle-ship of any kind. With almost incredible folly the very Congress that declared the war voted down the bill to increase the navy by twenty battleships, though it was probably too late then anyhow, for even under the simpler conditions of that day such a fleet could not have been built and put into first-class order in less than a couple of years. Bitterly did the nation pay for its want of foresight and forethought. Our cruisers won a number of striking victories, heartening and giving hope to the nation in the face of disaster; but they were powerless to do material harm to the gigantic naval strength of Great Britain. Efforts were made to increase our little navy, but in the face of a hostile enemy already possessing command of the seas this was impossible. Two or three small cruisers were built; but practically almost all the fighting on the ocean was done by the handful of frigates and sloops which we possessed when the war broke out. Not a battle-ship was able to put to sea until after peace was restored. Meanwhile, our coast was blockaded from one end to the other, and was harried at will by the hostile squadrons. Our capital city was burned, and the ceaseless pressure of the blockade produced such suffering and irritation as nearly to bring about a civil war among ourselves. If in the first decade of the present century the American people and their rulers had possessed the wisdom to provide an efficient fleet of powerful battle-ships there would probably have been no War of 1812; and even if war had come, the immense loss to, and destruction of, trade and commerce by the blockade would have been prevented. Merely from the monetary standpoint, the saving would have been incalculable; and yet this would have been the smallest part of the gain.

It can therefore be taken for granted that there must be adequate preparation for conflict, if conflict is not to mean disaster. Furthermore, this preparation must take the shape of an efficient fighting navy. We have no foe able to conquer or overrun our territory. Our small army should always be kept in first-class condition, and every attention should be paid to the national guard; but neither on the north nor the south have we neighbors capable of menacing us with invasion, or long resisting a serious effort on our part to invade them. The enemies we may have to face will come from over sea; they may come from Europe, or they may come from Asia. Events move fast in the West; but this generation has been forced to see that they moved even faster in the oldest East. Our interests are as great in the Pacific as in the Atlantic, in the Hawaiian Islands as in the West Indies. Merely for the protection of our own shores we need a great navy, and, what is more, we need it to protect our interests in the islands from which it is possible to command our shores and to protect our commerce on the high seas.

In building this navy we must remember two things: first, that our ships and guns should be the very best of their kind; and second, that no matter how good they are they will be useless unless the man in the conning tower and the man behind the gun are also the best of their kind. It is mere folly to send men to perish because they have arms with which they cannot win. With poor ships, were an Admiral Nelson and Farragut rolled in one, he might be beaten by any first-class fleet, and he surely would be beaten if his opponents were in any degree his equal in skill and courage; but without this skill and courage no perfection of material can avail, and with them very grave shortcomings in equipment may be overcome. The men who command our ships must have as perfect weapons ready to their hands as can be found in the civilized world, and they must be trained to the highest point in using them. They must have skill in handling the ships, skill in tactics, skill in strategy, for ignorant courage cannot avail, but without the courage neither will skill avail. They must have in them the dogged ability to bear punishment; the power and desire to inflict it; the daring, the resolution, the willingness to take risks and incur responsibility which have been possessed by the great captains of all ages, and without which no man can ever hope to stand in the front rank of fighting men.

Tame submission to foreign aggression of any kind is a mean and unworthy thing, but it is even meaner and more unworthy to bluster first and then either submit or else refuse to make those preparations which can alone obviate the necessity for submission. I believe with all my heart in the Monroe Doctrine, and I believe also that the great mass of the American people are loyal to it; but it is worse than idle to announce our adherence to this doctrine and yet to decline to take measures to show that ours is not mere lip-loyalty. We had far better submit to interference by foreign powers with the affairs of this continent than to announce that we will not tolerate such interference and yet refuse to make ready the means by which alone we can prevent it. In public as in private life a bold front tends to insure peace and not strife. If we possess a formidable navy, small is the chance indeed that we shall ever be dragged into a war to uphold the Monroe Doctrine. If we do not possess such a navy, war may be forced on us at any time.

It is certain, then, that we need a first-class navy. It is equally certain that this should not be merely a navy for defense. Our chief harbors should of course be fortified and put in condition to resist the attack of an enemy's fleet; and one of our prime needs is an ample force of torpedo-boats to use primarily for coast defense. But in war the mere defensive never pays and can never result in anything but disaster. It is not enough to parry a blow. The surest way to prevent its repetition is to return it. No master of the prize ring ever fought his way to supremacy by mere dexterity in avoiding punishment. He had to win by inflicting punishment. If the enemy is given the choice of time and place to attack, sooner or later he will do irreparable damage, and if he is at any point beaten back, why after all it is merely a repulse and there are no means of following it up and making it a rout. We cannot rely upon coast protection alone. Forts and heavy land guns and torpedo-boats are indispensable, and the last, on an occasion, may be used for offensive purposes also. But in the present state of naval and military knowledge we must rely mainly, as all great nations always have relied, on the battle-ship, the fighting ship of the line. Gunboats and light cruisers serve an excellent purpose, and we could not do without them. In time of peace they are the police of the seas; in time of war they would do some harrying of commerce and a great deal of scout-

ing and skirmishing, but our main reliance must be on the great armored battle-ships with their heavy guns and shot-proof vitals. In the last resort we must trust to the ships whose business it is to fight and not to run, and who can themselves go to sea and strike at the enemy when they choose, instead of waiting peacefully to receive his blow when and where he deems it best to deliver it. If in the event of war our fleet of battle-ships can destroy the hostile fleet, then our coasts are safe from the menace of serious attack; even a fight that ruined our fleet would probably so shatter the hostile fleet as to do away with all chance of invasion; but if we have no fleet wherewith to meet the enemy on the high seas or to anticipate his stroke by our own, then every city within reach of the tides must spend men and money in preparation for an attack that may not come, but which would cause crushing and irredeemable disaster if it did come.

Still more is it necessary to have a fleet of great battle-ships if we intend to live up to the Monroe Doctrine and to insist upon its observance in the two Americas and the islands on either side of them. If a foreign power, whether in Europe or Asia, should determine to assert its position in those lands wherein we feel that our influence should be supreme, there is but one way in which we can effectively interfere. Diplomacy is utterly useless where there is no force behind it; the diplomat is the servant, not the master, of the soldier. The prosperity of peace, commercial and material prosperity, gives no weight whatever when the clash of arms comes. Even great naked strength is useless if there is no immediate means through which that strength can manifest itself. If we mean to protect the people of the lands who look to us for protection from tyranny and aggression; if we mean to uphold our interests in the teeth of the formidable Old World powers, we can only do it by being ready at any time, if the provocation is sufficient, to meet them on the seas, where the battle for supremacy must be fought. Unless we are prepared so to meet them, let us abandon all talk of devotion to the Monroe Doctrine or to the honor of the American name.

This nation cannot stand still if it is to retain its self-respect and to keep undimmed the honorable traditions inherited from the men who with the sword founded it and by the sword preserved it. We ask that the work of upbuilding the navy and of putting the United States where it should be put among maritime

powers go forward without a break. We ask this not in the interest of war, but in the interest of peace. No nation should ever wage war wantonly, but no nation should ever avoid it at the cost of the loss of national honor. A nation should never fight unless forced to; but it should always be ready to fight. The mere fact that it is ready will generally spare it the necessity of fighting. If this country now had a fleet of twenty battleships, their existence would make it all the more likely that we should not have war. It is very important that we should as a race keep the virile fighting qualities and should be ready to use them at need; but it is not at all important to use them unless there is need. One of the surest ways to attain these qualities is to keep our navy in first-class trim. There never is, and never has been, on our part a desire to use a weapon because of its being well-tempered. There is not the least danger that the possession of a good navy will render this country overbearing towards its neighbors. The direct contrary is the truth.

An unmanly desire to avoid a quarrel is often the surest way to precipitate one, and utter unreadiness to fight is even surer. If at the time of our trouble with Chile six years ago we had not already possessed the nucleus of the new navy we should almost certainly have been forced into fighting, and even as it was, trouble was only averted because of the resolute stand then taken by the President and by the officers of the navy who were on the spot. If at that time the Chileans had been able to get ready the battle-ship which was building for them, a war would almost certainly have followed, for we had no battle-ship to put against it.

If in the future we have war, it will almost certainly come because of some action, or lack of action, on our part in the way of refusing to accept responsibilities at the proper time, or failing to prepare for war when war does not threaten. An ignoble peace is even worse than an unsuccessful war; but an unsuccessful war would leave behind it a legacy of bitter memories which would hurt our national development for a generation to come. It is true that no nation could actually conquer us, owing to our isolated position, but we would be seriously harmed, even materially, by disasters that stopped far short of conquest; and in these matters which are far more important than things material, we could readily be damaged beyond repair. No material loss can

begin to compensate the loss of national self-respect. The damage to our commercial interests by the destruction of one of our coast cities would be as nothing compared to the humiliation which would be felt by every American worthy of the name if we had to submit to such an injury without amply avenging it. It has been finely said that "a gentleman is one who is willing to lay down his life for little things," that is, for those things which seem little to the man who cares only whether shares rise or fall in value, and to the timid doctrinaire who preaches timid peace from his cloistered study.

Much of that which is best and highest in national character is made up of glorious memories and traditions. The fight well fought, the life honorably lived, the death bravely met—these count for more in building a high and fine type of temper in a nation than any possible success in the stock market, than any possible prosperity in commerce or manufactures. A rich banker may be a valuable and useful citizen; but not a thousand rich bankers can leave to the country such a heritage as Farragut left, when, lashed in the rigging of the Hartford, he forged past the forts and over the unseen death below, to try his wooden stem against the iron-clad hull of the great Confederate ram. The people of some given section of our country may be better off because a shrewd and wealthy man has built up therein a great manufacturing business or has extended a line of railroad past its doors, but the whole nation is better, the whole nation is braver, because Cushing pushed his little torpedo-boat through the darkness to sink beside the sinking Albemarle.

Every feat of heroism makes us forever indebted to the man who performed it. All daring and courage, all iron endurance of misfortune, all devotion to the ideal of honor and of the glory of the flag, make for a finer and nobler type of manhood. It is not only those who do and dare and endure that are benefited, but also the countless thousands who are not themselves called upon to face the peril, to show the strength or to win the reward. All of us lift our heads higher because those of our countrymen whose trade it is to meet danger have met it well and bravely. All of us are poorer for every base or ignoble deed by an American, for every instance of selfishness or weakness or folly on the part of the people as a whole. We are all worse off when any of us fails at any point in his duty toward the State in time of

peace or his duty towards the State in time of war. If ever we had to meet defeat at the hands of a foreign foe, or had to submit tamely to wrong or insult, every man among us worthy of the name of American would feel dishonored and debased. On the other hand, the memory of every triumph won by Americans, by just so much helps to make each American nobler and better. Every man among us is more fit to meet the duties and responsibilities of citizenship because of the perils over which in the past the nation has triumphed; because of the blood and sweat and tears, the labor and the anguish, through which, in the days that have gone, our forefathers moved on to triumph. There are higher things in this life than the soft and easy enjoyment of material comfort. It is through strife, or the readiness for strife, that a nation can win greatness. We ask for a great navy, partly because we think that the possession of such a navy is the surest guarantee of peace, and partly because we feel that no national life is worth having if the nation is not willing, when the need shall arise, to stake everything on the supreme arbitrament of war, and to pour out its blood, its treasure and tears like water rather than submit to the loss of honor and renown.

In closing, let me repeat that we ask for a great navy; we ask for an armament fit for the nation's needs, nor primarily to fight, but to avert fighting. Preparedness deters the foe and maintains right by the show of ready might without the use of violence. Peace, like freedom, is not a gift that tarries long in the hands of cowards or of those too feeble or too short-sighted to deserve it, and we ask to be given the means to ensure that honorable peace which alone is worth having.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE CONSOLIDATED MESS OF THE CREW OF THE U. S. S. INDIANA.

By Lieut. BENTON C. DECKER, U. S. Navy.

The consolidated mess has been in operation on the Indiana since May 1st, 1896. The term "consolidated mess" comes from the fact that all the independent messes, with their cooks, caterers and mess funds, are consolidated into one general mess.

The mess, since starting, has had the advantage of the personal interest and assistance of the executive officer. As assistant he had a junior line officer who carried out the details and, later, was given charge of the mess by order of the Bureau of Navigation. Upon the latter's detachment the mess was turned over to the paymaster.

The mess as now organized consists of about three hundred and eighty men, a ship's cook of the 1st class, two of the 2nd class, and four of the 3rd class, a commissary yeoman and a storeroom keeper. Of all the ship's company only the chief petty officers and the officers' servants are excused from joining the mess.

Two of the cooks are stationed in the bakery, the others work at the galley. In addition to the cooks there are messmen, taken from the landsmen, who receive the ration at the galley and serve it to the mess. The messmen are responsible for the mess equipage.

The officer in charge is responsible for the money handled, the paying of bills and the settlement of the ration. The fund for provisioning the mess comes from the commuted rations, one-half of all in the mess, and the canteen. The commissary yeoman looks out for the buying and transporting of the provisions to the ship and has charge of the galley cooks. He also has charge of the canteen.

Every assistance has been rendered to make the mess a success. Cooks have been allowed by the Department, a bake oven supplied, rations commuted, and the ration of hard bread converted to flour. The government ration is issued to the mess in bulk, and handled by it to the best advantage. In general, it is stored for issue at sea, or providing for meals when disappointed by contractor. Canned goods being more expensive than fresh provisions, it is a loss to the mess to issue them in port. In this ship it would be better for the mess, it is thought, if more rations were commuted.

A spare coal bunker on the berth deck has been converted into a storeroom and serving-out stand. The consolidating of the messes renders the subdividing of the cold storage room unnecessary and causes it to serve the crew much more efficiently.

The centralization of the ration for the crew tends to make its distribution more economical. The services of a few trained, well paid cooks ensure the proper preparation of the ration and no waste from badly cooked food.

Under the former system each mess bought its extra provisions in small quantities from a ship chandler that came off to the ship. The time consumed, the expense of transportation, and the small quantities bought, all tended to make the prices high. Under the new system all the advantages of buying in large quantities are gained. The provisioning of four hundred men is a large contract and dealers can afford to give discounts, especially knowing that their pay is certain. Such discounts small messes acting singly could not get. The fact that the contract can be revoked without any of the formalities of a government contract aids in securing the delivery of provisions fully up to the requirements. As a check, the accounts of the officer in charge were audited by the paymaster at the end of each month. All bills have been paid with paymaster's checks.

The opposition to the mess was great at first, and many expressed the opinion that it would be better to return to the old system. But in spite of discouragement and lack of appreciation of the work that was being done, the mess was maintained and prospered. The opposition was soon found to come from two classes, the first class petty officers and the mess cooks. The former felt that they had a grievance in that they were required to eat the same ration as the other members of the crew. Their

pay was sufficient to enable them to pay a large mess assessment, and the quality of their fare was reduced some. As for the mess cooks they no longer received all the perquisites of the berth deck cook of former days, and naturally opposed the plan. The opposition of the petty officers was shown in complaints at the mast regarding the quality and quantity of the ration; that of the cooks in the spoiling and wasting of the food, and in lack of care in serving the ration to the members of the mess, so that some went hungry and others were surfeited. As time passed the opposition weakened and has now apparently died out. New men joining the ship from time to time saw the advantages of the new mess and convinced their messmates that they were well off. Such words as the following, from a petty officer, have weight: "I never lived better." "The month before coming to the ship two caterers ran away with the mess money and we had to pay an extra assessment." Here he lived better without any assessment. There was opposition from the firemen on the ground that the ration was not substantial enough, and too little of it. This was remedied on later passages by giving them beans and coffee when they went on a mid or morning watch. This the mess could afford to do. Needless to say the trouble ended.

At the time the mess was organized a canteen was started for the selling of beer. By doing this, all the profits went toward bettering the food that could be furnished, the quality of the beer could be assured, the quantity consumed regulated, and the price maintained uniform, allowing a reasonable profit. The profits went, in part, to make a reserve fund against the time when it would be necessary to lay in sea stores. During the time the canteen has been running the profits have been about $3000. There is now on hand a reserve fund of about $2000. From now on the profits of the canteen can be devoted to raising the quality of the food and providing for extra occasions, such as Christmas.

It has been stated that the mess could not be maintained on foreign stations, at sea, or in ports where food supplies cost more than in the markets of the large cities of our own country. The advantages of the cooking being done by capable cooks, the economy of handling the entire ration, government or special, and the bakery supplying fresh bread every day, cannot be lost. It is thought that it would be impossible to secure these advantages where there are separate messes.

In regard to the mess gear, the Department has supplied this to the ship. The consolidated mess took this mess gear and deposited the money value with the paymaster, relieving the executive officer of any care in the matter.

The attempt has been made to show briefly the important features of the system, its present financial prosperity, and the trials that attended its introduction. A great amount of patience and perseverance has been required, as was to be expected from the breaking up of time-honored customs, and the known opposition of "Jackey" to any encroachment on what he considers his rights.

The chief advantage of the system is thought to be that the men are constantly provided with a wholesome, steady diet. There will no longer be caterers running off with the mess money and the mess living on "hard bread and coffee." Mess money cannot be devoted to betting on boat races. Poor landsmen, in debt, are no longer seen at the mast begging for a few dollars to put in the mess. The indigestible messes served up by ignorant landsmen are no longer seen. The money paid cooks formerly is now saved to the men, the only cooks that are allowed extra compensation being the galley cooks; the chief cook receiving one ration and the others, each, half a ration. There is no longer the trouble between messes as to the stowing of sea stores and the finding of them in every stowhole. In landing drill the advantage of the system would be further shown. During the past summer the men from the Indiana were supplied with a substantial ration of sandwiches, sardines, and hot coffee, without any inconvenience.

The ration is an excellent one. Each day the government ration of fresh meat and eighteen ounces of fresh bread is allowed.

The following bill of fare was taken indiscriminately :

Breakfast: eggs, liver and bacon, coffee, bread and butter.

Dinner: fresh corn beef and cabbage, potatoes, new onions and radishes, coffee, bread and butter.

Supper: chicken stew, tea, bread and butter—condensed milk and sugar being supplied for the coffee and tea.

The following is a sample of the usual Sunday dinner : roast pork, jelly, fresh green peas, new potatoes, pie.

The foregoing shows what can be done in a good market. Of

course this could not be maintained where food was more expensive.

It is the expressed opinion of officers of this ship that the consolidated mess is a success. All the advantages attendant upon the better feeding of men must follow upon the successful running of such a mess.

(*Discussion at end of number.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE SAILOR IN THE REVOLUTION.*

By Commander C. F. Goodrich, U. S. Navy.

It is not my purpose to recount in detail the naval episodes of the War of the American Revolution, although all are interesting and many thrilling. This work has been too often done by abler hands than mine to call for, or to admit of, repetition. The pages of Jas. Fenimore Cooper, for example, are a guide to these events whose trustworthiness is beyond question and above praise.

In reading the history of this struggle, great in itself and greater still in its consequences to mankind, having in view the obtaining of lessons appropriate to our present needs, I have been much impressed by the absence of those broad generalizations which, alone, bring benefit to the student, illuminating his path with the lamp of experience. The lamp has always been burning, giving forth its rays in every direction with lavish generosity; but, as far as I am aware, there has been lacking that accurate synthesis which, placing the facts in their true relation to each other, should serve as a lens to bring the rays of light together into one powerful and searching beam. I cannot pretend to have found this lens myself, but, at least, certain deductions from these events have suggested themselves to me as worthy of consideration, if not of acceptance, and to them I ask your attention for a brief time.

The war in question was a naval war to an extent seldom fully realized and never generally acknowledged. That the war

* Read before the Military Historical Society of Massachusetts, March 17, 1896, the Army and Navy Club of Washington, January 11, 1897, and the Seawanhaka Corinthian Yacht Club, January 19, 1897.

would assume this phase might have been expected on *à priori* grounds. England was waging hostilities at a distance of some three thousand miles from home. For the maintenance of communication between her troops in America and their base in Great Britain, the command of the sea was an imperative necessity. Let that be lost and her armies in the colonies would infallibly perish; for military stores were not to be had in the theatre of operations, and other supplies were often difficult to obtain in the midst of a population for the greater part intensely inimical. Again, the colonists, settled principally along the seaboard, had been engaged in maritime pursuits to a degree which, proportionally, has not been surpassed in our history. As fishermen and sailors their numbers were relatively vast. Their enterprise and skill brought, indeed, so serious a menace to England's commercial supremacy on the water that among their grievances were measures which sought to restrict this energetic competition with the mother country. As a natural sequence, these men of nautical bent and experience found an appropriate field for activity in attacks on British transports and British merchantmen, provoking, in return, a large display of British naval force. The numbers engaged in these operations afloat were so much greater than those under arms ashore that the latter appear, by comparison, almost insignificant.

In actual organized collision between the King's forces and the colonists, the first blood was shed on the water in the *Gaspee* incident of 1772. It was also a naval movement that brought the war to a close, for without the help of the French fleet Washington and Lafayette could not have compelled the surrender of Cornwallis, the last important scene in the military drama. Surely these facts justify our looking at this war from the naval standpoint and absolve me from the need of further apology for inviting you to listen once more to a twice-told tale.

The occasion of the *Gaspee* episode was the attempted enforcement of the odious Navigation Act by British armed vessels, charged with the duty of seeing that all colonial craft were provided with the stamps made requisite under the law. On June 9th, 1772, the *Hannah*, Captain Linzee, a packet plying between New York and Providence, refused to come for examination alongside a British cruiser in Narragansett Bay, but, profiting by a fresh and favoring breeze, she ran off and stood up the bay.

The sloop *Gaspee*, of 102 tons, a small armed tender to the cruiser, mounting four or six 3-pdrs., was signaled to chase. Capt. Linzee, familiar with the local navigation, led the *Gaspee* over a shoal where, drawing more water than the *Hannah*, the former struck, while the latter escaped to Providence. Capt. Linzee's account of the matter so incensed the inhabitants of that town that they planned and fitted out an expedition to avenge the fancied outrage. Sixty-four men, disguised as Indians and led, it is believed, by Captain Abraham Whipple, later one of the first captains to be commissioned in the United States Navy, dropped down the river that night in eight boats, provided mainly with cobble-stones as missiles. At 2 a. m. they reached the stranded *Gaspee*. They were hailed by the sentry, who received a volley of stones in reply. He rushed below to rouse his mates. Lieutenant Dudingstone, in command, came on deck and fired a pistol at the boats. He was wounded in the thigh by a musket-ball discharged in return. The *Gaspee* was carried by boarding, and Dudingstone was further injured by a sabre cut that nearly severed his right hand from the wrist. The Gaspee's people were removed and the vessel set on fire. Towards morning she blew up. A reward of a thousand pounds sterling for the leader and one of five hundred pounds for any of the others in this party were offered in vain by the British government. Nor were the labors of a royal commission that sat from January till June of the following year, attended by better results. The loyalty of the colonists to each other was proof against all temptation. The affair may, with propriety, be deemed the opening act of hostilities between England and her American possessions. Preceding Lexington by nearly three years, it has been lost sight of in the latter's greater renown—a renown based upon the larger numbers engaged, upon a notable loss of life on both sides, and upon the stirring events to which it was the immediate prelude. I have thought it not improper to describe the taking of the *Gaspee* at some length, and to claim for the enterprise its due place in the order of events.

From a military point of view, the position of England on the continent of North America from 1775 to 1782 was alternately offensive and defensive; offensive so long as her command of the sea was practically unchallenged or undisturbed, defensive the moment her communications were seriously threatened or

were interrupted. It is these varying phases, presented by the military situation, which so complicate the general question and render difficult a right understanding of the British campaign as a whole. Yet it is evident that just so long as she could safely play the part of aggressor her advance was, on the whole, not measurably checked. When her sea communications were endangered, the movements of her troops became retrograde at once. Thus in 1776 the continued interception of its supplies by American cruisers was of little if any less weight in forcing the British army to evacuate Boston than the increasing pressure of the besieging Americans. Again, in 1778, it was not Washington's army, but the sailing of d'Estaing's fleet from Toulon that drove Clinton out of Philadelphia and back upon his local base in New York.

A year later the mere news that d'Estaing was coming to America was sufficient to cause the precipitate abandonment of Rhode Island by the British.

Arguing from these facts, it becomes at least conceivable that measures directed towards naval control of the coast on our part might have materially shortened the war.

The steps taken by the colonists to prosecute hostilities on the water reflected the lack of organization existing at the seat of the new government. There were privateers, cruisers equipped by individual colonies, and national cruisers. These vessels acted in concert or independently, according to circumstances. Similarly, officers of the regular navy are found serving in each class, passing from one to the other as occasion demanded. A distressing absence of homogeneity is noticeable throughout all the American operations. If the word were permissible, amateurish would appear to be that best adapted to characterize them. Let us review briefly the services performed by each of the above-mentioned varieties of ships.

The old and ever new *ignis fatuus* of commerce-destroying shed its baleful light over the colonists, luring them on to a false policy. As a subordinate adjunct, prosecuted with a surplus of ships and men, and so controlled as to help and not hinder regular hostilities, commerce-destroying is always useful, while, at times, important. But when, as in the War of the American Revolution, it cripples the crews of national vessels, and through frequent capture by the enemy followed by non-exchange of

prisoners, it gradually decimates the seafaring population; when it assumes a magnitude out of all proportion to the more capital operations of the marine, it becomes an evil but slightly, if at all, mitigated by the distress inflicted on the foe. Wars are brought to a conclusion by the defeat of armies and squadrons, not by guerillas, however successful, either afloat or ashore. The damage done to our commerce by the Confederate cruisers in the War of the Rebellion, vast as it was, had absolutely no effect on the issue of the contest. This lesson has never been learned by our people, yet it is as true to-day as it was thirty-five or even one hundred and twenty years ago.

Hutchinson in his diary states his belief that seventy thousand New Englanders were engaged in privateering at one time. According to Edward Everett Hale, the privateer fleet of the port of Salem, in 1781, consisted of fifty-nine vessels, which carried nearly four thousand men, averaging sixty-six men to the ship, and mounted seven hundred and forty-six guns. There seems to be no means of making an exact computation of the magnitude of the privateer fleet at any one moment, but a partial list in the Massachusetts Archives of those commissioned in that State gives the names of two hundred and seventy vessels. The privateer fleets from Rhode Island, Connecticut and Philadelphia were also large. Salem is known to have sent out one hundred and fifty privateers and Boston three hundred and sixty-five. It would probably be fair to say that during the war more than six hundred privateers were commissioned by Massachusetts alone. "The largest of these privateers," says Mr. Hale,* "at starting carried one hundred and fifty men. With each prize sent in the fighting force of the captor was reduced, and in such reduction is the reason to be found why at last a privateer captain was not able to fight his own ship and, after he had sent in many prizes, was himself taken. On the other hand, the smallest of these vessels, equipped for short cruises, carried but few guns and few men."

I have been unable to gather statistics as to the number of privateers sailing from the Delaware, from Southern waters or from France.

That an amount of injury commensurate with this display of force was dealt to English transports and merchantmen is con-

* E. E. Hale, in Crit. and Narr. Hist. America.

ceded. Almon's Remembrancer records three hundred and forty-two sail of English vessels taken by American cruisers of all kinds in 1776. In the following year, four hundred and sixty-seven were captured, some of them of great value. In the single month of May, 1779, eighteen prizes were brought into the port of New London. In 1780, the Admiralty court of the Essex district of Massachusetts had condemned eight hundred and eighteen prizes. Of this period Cooper says, "Many American privateers fell into their [British] hands, and a scarcity of men began to be felt in consequence of the numbers that were detained in English prisons."

Not the least of the bad results of privateering on such a large scale was the difficulty of obtaining crews for the national ships, the naval service holding out fewer and less specious attractions to recruits than did the privateer with its short trips, lax discipline and chances of greater gain. This difficulty, by the way, is likely to recur with a renewal of the conditions which gave it birth.

The privateers were an excellent school of seamanship and battle. It would ill become us at this day to withhold our tribute of praise for their brave deeds, however much we may regret the misapplication of their valuable powers.

Such achievements as the surrender of the *Governor Tryon*, 16, and the *Sir Wm. Erskine*, 18, to the American privateer *Thorn*, 16, Captain Daniel Waters, should not be forgotten. True, the *Tryon* managed to escape while Waters was securing the *Erskine*, but this mishap was partially repaired a few days later, when on his way to Boston he captured the *Sparlin*, 13, bringing in the two prizes which he had apparently set his heart upon taking. In like manner Captain Manly of the *Jason*—probably of 20 guns —being attacked by two English privateers, one of 16 and the other of 18 guns, boldly ran between them and captured them both. Nor is the action on September 6th, 1781, between the *Congress*, 20, Captain Geddes, and H. B. M. sloop-of-war *Savage*, 16, Captain Sterling, less notable. The heavier ship won the fight, but she had to contend against the man-of-war's superior drill and discipline consequent upon an already long commission. The privateer's crew were raw and untrained, the vessel being just out of port. An aptitude for such work combined with zeal and intrepidity to make their superior weight of metal effective. Our time is too limited to recall other equally gallant encounters

in which American privateers gained honorable laurels, even if they came fairly within the scope of this study.

The colonial navies were not insignificant in numbers at least, though many of the vessels under this head were small and weak. The navy of Massachusetts comprised thirty-four craft from the beginning to the end of the war. As early as February 16th, 1776, South Carolina had a ship of 26 guns, a brig of 18 guns and a schooner of 12 guns. Others were added later. Among them was the *South Carolina*, borrowed from the King of France, much the heaviest ship that ever sailed under the American flag until the frigates of 1794 were built. Connecticut, Rhode Island and Pennsylvania also commissioned armed vessels. Virginia's navy appears to have consisted of small light-draught boats suitable for operating in the waters tributary to Chesapeake Bay. Beatson mentions the scuttling or burning in the James River in March, 1781, of the *Tempest*, 20, *Renown*, 26, and *Jefferson*, 14, "State ships." These probably belonged to Virginia. I am not able to give numbers with any possible approach to accuracy, but it may be assumed that not less than sixty were in active service at one time or another.

The work of these colonial cruisers was only less important than that of the national vessels. The former generally acted singly, in this respect differing from the latter, which not infrequently sailed in groups. Indeed, the naval operations of the war were begun by the little schooner *Lee*, belonging to Massachusetts, under the command of John Manly, whose later success in the *Jason* has been already mentioned. The *Lee* was the first vessel of any kind to sail with authority to cruise on behalf of the entire republic. Her capture on November 29th, 1775, of the British brig *Nancy*, laden with military stores for General Gage, brought sorely needed supplies to the Colonial troops about Boston. The following June she was helped out of a serious scrape by the only less famous Connecticut brig *Defence*. The two, aided by three privateer schooners, reversed the condition of affairs and captured two armed transports filled with troops which had just proved too heavy for the schooners alone. Captain John Foster Williams seems to have earned more than one man's share of glory, for he not only captured H. B. M. S. *Active*, 18, while in command of the Massachusetts cruiser *Hazard*, 14, in 1779, but shortly afterwards in the *Protector*,

belonging to the same State, he fought a large letter-of-marque, the *Duff*, said to have been of equal force. The *Duff* blew up in the action. On her way home the *Protector* had a sharp running fight with the frigate *Thames*, 32, and escaped through skillfully crippling the *Thames* aloft by her well-aimed fire. The action between the Pennsylvania cruiser *Hyder Ally*, 16, and H. B. M. S. *General Monk*, 18, which occurred in the mouth of the Delaware in March, 1782, was one of the most brilliant single-ship engagements of which we have any account. Captain Barney well deserves the glory with which song and story invest him as the hero of this dramatic event for his skill and bravery in compelling success against a superior force within sight of a British frigate and a British privateer brig.

As to the national cruisers, history is somewhat more explicit, although doubts arise in certain cases touching the identity of individual vessels, the readiness with which a ship or an officer passed into or out of the general service obscuring the record.

The first effort at securing a navy bears date of October 13th, 1775, when Congress passed a law ordering one vessel of 10 guns and another of 14 guns, to be equipped and sent on a cruise to the eastward to intercept royal supplies. Two months later it directed the construction of thirteen ships, three of 24 guns, five of 28 guns and five of 32 guns. Of these the *Raleigh*, *Boston* and *Montgomery* bore names still to be found on our navy register, from which those of the *Warren*, *Congress* and *Delaware* have but comparatively recently been erased. On October 3, 1776, it authorized another frigate and two cutters, and on November 9, 1776, three 74s, five more frigates, one sloop-of-war and a packet. The need of heavy ships was beginning to be perceived, at least in theory. Practically but one 74, the *America*, was laid down, and she was presented to France the day of her launching in 1782 to replace the *Magnanime* of de Vandreuil's squadron, lost while attempting to enter Boston harbor. On the 22d of December, 1775, Congress appointed Esek Hopkins of Rhode Island, commander-in-chief, four captains, each by name, to the purchased vessels, *Alfred*, *Columbus*, *Andrea Doria* and *Cabot*, together with thirteen lieutenants. Of the latter, John Paul Jones was senior.

The *Hornet*, 10, sloop, and the *Wasp*, 8, schooner, were the first regular cruisers to get to sea. As time went on, others were

purchased or borrowed or hired. Thus in October, 1776, the list comprised the thirteen building under the act of December, 1775, besides thirteen more otherwise acquired. From the beginning to the end of the war the United States had forty-one vessels in commission, including the *Bonhomme Richard* and her four Franco-American consorts. Some of these never got to sea.

Cooper says of the vessels of the act of 1775: "The ships ordered were large enough to resist the small cruisers of the crown, and were well adapted to destroy convoys and to capture transports and store-ships. . . . Most of the ships mentioned . . . were armed with nines and twelves, having sixes, or even fours, on their quarterdecks and forecastles. It is thought that there were no eighteen-pounder frigates constructed under the laws of 1775." You will perceive that of the necessity for ships for purely military purposes there seems to have been no conception except as embodied in the three 74's that never materialized. Commerce-destroying and the intercepting of supplies seem, as is our custom, to have controlled the building programme. The fate experienced by the majority of these vessels was abundantly foreshadowed in their light scantling and Fourth of July batteries.

On the British side we see on our coast a rough average of 26,000 sailors in seventy or more vessels of various sizes. Thus Lord Howe had six 64's and three 50's at New York in 1778 before Byron's fleet, which counted 74's among its number, arrived to reinforce him. Howe's ships alone were an easy match for all we could possibly gather under one command.

The comparison by numbers, both of ships and men, employed by the two contestants is greatly in favor of the Americans, but they never had afloat a single vessel able to challenge the British 64's, or even 50's, while the advantages of organization, discipline, *esprit de corps* and service traditions lay wholly with their enemies. Too often, indeed, our crews were made up in part of British prisoners, who in return for their release agreed to serve in our navy. The mutiny on board the *Alliance* in 1779 would doubtless have succeeded but for its timely detection. It was planned by the released British seamen in the crew. The loss of the U. S. S. *Trumbull*, 24, in 1781 was largely due to the presence in her ship's company of "these questionable materials," to use Cooper's expression, to the extent of more than one-fourth of a

scant 200. These men so influenced their comrades that in the confusion of the damage occasioned by a sudden squall and in the darkness of the night the captain could not muster fifty of his men to fight the *Iris*, 32, and *General Monk*, 18. The battle might also be said to have been fought by the officers.

It followed, inevitably as night follows day, with ships often hastily improvised, badly manned, poorly equipped, heterogeneous in type and handled without unity of purpose or clear notions of strategy, that there was a corresponding waste of energy and barrenness of result. Individual acts of brilliant seamanship and great gallantry abound. What could have been finer than Nicholas Biddle's behavior in the *Randolph*, 32, when, finding he had engaged, not an armed merchantman as he supposed the *Yarmouth*, 64, he pluckily fought his great antagonist until his own ship blew up? To mention John Paul Jones and the *Bonhomme Richard* is to recall to mind one of the most extraordinary and stubbornly contested naval battles recorded in history. Indeed, with scarcely an exception, the American flag was flown with such credit and defended with such vigor as to compel our adversaries to acknowledge that with equal ships their chances of victory were no greater than ours. I know of no better specific for a relaxed condition of patriotism than the reading of the glowing pages of Cooper which describe these exploits. But ours is a different task. Let us contrive, if possible, to obtain a general view of the naval campaign.

In the early part of 1776 the Commander-in-Chief, Esek Hopkins, with a force consisting of the purchased vessels *Alfred*, 24, *Columbus*, 20, *Doria*, 14, *Cabot*, 14, *Providence*, 12, *Hornet*, 10, *Wasp*, 8, and *Fly*, despatch, left the Delaware under instructions to proceed to the southward with a view to act against the naval force, which, under Lord Dunmore, was then ravaging the coast of Virginia. Instead of executing his orders, Hopkins made a descent on New Providence, in the Bahamas, where he captured a number of cannon and other military stores. For his failure to do as directed and for his mishap in engaging without result the *Glasgow*, 20, on his way home, Hopkins was eventually dismissed the service. In this case it was the naval commander who misapprehended the right use to make of a fleet, viz., for the destruction of the enemy's armed force.

The navy of the United States after this miscarriage, with but

rare exceptions, was employed in disconnected cruises against British commerce and British transports. It deliberately declined the purely military rôle for which its weakness ill adapted it, and sought by desultory raids to compensate for its lack of strength. When a favorable opportunity offered, it did not hesitate to engage the enemy on even terms, but these opportunities were not so much by choice as by hazard. The prizes captured were often a welcome, if intermittent, source of revenue. This is especially true of those taken in European waters by such craft as the *Surprise* and *Revenge* under Conyngham and the *Bonhomme Richard* and her mates under Jones, all fitted out by the American commissioners in France. That British trade was hampered, not to say demoralized, is abundantly proved by contemporaneous reports (the government was even obliged to furnish convoys for the Irish coast trade), but unless the high rates of marine insurance and the alarm of the mercantile community can be shown to have exerted a determining influence upon the conclusion of hostilities, it is yet open to question whether all these depredations had a direct military value at all comparable with the operations of a squadron of good vessels sailing with a correct strategic purpose.

The progress of the war was, naturally, marked by a steady decrease of our forces and as notable an increase of the British ships employed on our coast. Thus in 1776 we counted twenty-five vessels and four hundred and twenty-two guns to the enemy's seventy-eight and two thousand and seventy-eight respectively. Two years later we had but fourteen ships and three hundred and thirty-two guns; the English, eighty-nine ships and two thousand five hundred and seventy-six guns. Yet, in the meantime, the thirteen frigates and sloops authorized in 1775 had been built, launched and commissioned. The official list sent to Franklin in March, 1780, of the navy of the United States at that time comprises besides the *America*, 74, *Bourbon*, 36, and *Saratoga*, 18, on the stocks, only eight vessels mounting 222 guns. The enemy's command of the sea occasioned the loss of those members of this batch that were constructed in the Hudson and Delaware, with hardly a struggle on our part. When the British in 1777 moved into Philadelphia they first bottled up, then afterwards destroyed or captured the *Washington*, 32, *Effingham*, 28, *Delaware*, 24, *Andrea Doria*, 14, *Sachem*, 10, *Wasp*, 8, *Inde-*

pendence, 10, *Dolphin*, 10, a heartrending showing truly, and the most extensive disaster to which our little marine was ever subjected. The vessels built in New England were much more fortunate, all getting to sea with useful and honorable careers. The British investment was less strict off the Eastern coast than at New York and Philadelphia. One is unable to escape the regret that more ships and heavier were not laid down at Portsmouth, Salisbury, Providence, Mystic, and elsewhere in Massachusetts, Rhode Island and Connecticut.

The British naval operations were confined principally to guarding the over-sea communications and to containing, as military men say, the French squadron in Newport after the formation of the alliance. They were usually characterized by a want of energy, which is in striking contrast with the bold and masterful movements of England's later fleets under St. Vincent and Nelson. Lord Howe rose superior to the emergency of 1778, when d'Estaing arrived off Sandy Hook, but this instance of skill and vigor did not redeem a generally weak policy. For our part we could not have asked for poorer men in command of the British fleet than Howe's successors, Arbuthnot and Graves. It seems incredible that so careless a watch should have been kept over the harbors of New England with their potent menace in ships, sailors and shipbuilding facilities. In this neighborhood ingress and egress seem to have been only less free than in times of peace. We wonder whether this could have been the same navy which twenty years afterwards held Brest, Lorient, Rochefort, and indeed the whole coast of France in the relentless grip of a blockade which remains to this day the model of what such a measure ought to be.

The number of seamen voted by Parliament for the year 1775 was 18,000, but the figures rose by leaps and bounds as the war progressed until it reached the astonishing development of 90,000 in 1781.

When Vice-Admiral Samuel Graves arrived at Boston in June, 1774, to take command of the British naval forces on our coast, he found there no less than seventeen ships and vessels exclusive of his flagship, the *Preston*, and three divisions of transports.*

* Samuel Graves is not to be confounded with Thomas Graves who, seven years afterwards, was unfortunate enough to fail in his attempt to keep De Grasse out of the Chesapeake. The former was as energetic as the latter was incapable.

Beatson says, vol. IV, p. 47: "When Admiral Graves was under a necessity of recalling some of his cruisers, the better to block up the port of Boston, in terms of the act of Parliament, the Americans availed themselves of the weakness of the squadron and procured supplies to an astonishing degree; so that it required more ships than the Admiral could spare to carry the Boston Port Act into execution."

It was to this locality that the early activity of the British fleet was mainly confined. Besides the interception of ammunition and other stores, Graves took a prominent share in the military operations during the siege of Boston by the Continentals, covering with the *Somerset*, 64, the retreat through Charlestown from Lexington, guarding with his ships and boats the principal waterways, defending the British hay and cattle on the different islands in the harbor from destruction and raiding by the Americans, and especially lending valuable assistance on the day of Bunker Hill.

"The *Lively*, *Falcon* and *Spitfire* (on that occasion) anchored abreast of and below Charlestown, covered the landing of the troops and kept up a well-directed fire, as long as they could distress the enemy, without too much endangering their own people." (Beatson, IV, 76.)

During the fight the ships threw red-hot shot into Charlestown and burnt the town.

It was during the autumn of this year that Falmouth (now Portland) in Maine was burnt by a detachment under Mouat sent out by Graves in the ship *Canceaux*, the schooner *Halifax*, the sloop *Spitfire*, each mounting 6 guns, and the 18-gun armed transport *Symmetry*. What is not so generally known is that this was but one of a series of similar measures contemplated. Gloucester, Beverly, Marblehead, Salem, Newburyport, Portsmouth, Ipswich, Saco and Machias were ordered to be dealt with in this same brutal manner and in the order named. The wind prevented the British from reaching those highest on the list, so that the first blow fell in Maine. The outrages so aroused the whole coast that Mouat, the commander of the expedition, unable to go elsewhere, returned to Boston.

On the shores of Virginia Lord Dunmore was playing a similar part. He and Mouat appear to have been worthy apostles of the doctrine of harrying and ravaging with which Benedict

Arnold, after his treason, is most particularly identified. Well may the British chronicler write (Beatson, IV, p. 99): " . . . . the progress which hostilities had now made, aggravated by the occurrences of a predatory war, had inflamed the vindictive passions and carried both parties beyond the bounds of reconciliation."

In the meantime, through the vigorous and incessant intercepting of British transports and supply vessels by American cruisers and privateers, together with the wiser strategy attending Washington's assumption of general command on shore, the British garrison and fleet in Boston found themselves in a position which may, with moderation of expression, be termed precarious. On the 17th of March, 1776, the town was evacuated and Rear-Admiral Shuldham, Graves' successor, escorted and conveyed General Howe to Halifax, whence three months later they sailed for New York.

In the movements that eventuated in New York's falling into their hands, the British navy took a full, eager and creditable share.

With the exception of what, for want of a better term, may be vaguely called blockading duty, the British navy seems to have acted largely as an auxiliary to the army until the advent of the French squadrons. It is needless to enter into the details of the numberless minor joint enterprises that were undertaken. The raiding and burning of towns along the Sound in particular and the coast in general may be recalled in illustration.

The habitual monotony of the British operations was broken on several occasions. In June, 1776, Sir Peter Parker made his attempt on Charleston, wherein he proved, for the hundredth time, the inferiority of ships to forts under ordinary conditions of direct attack, and wherein Moultrie and his palmetto logs won the lion's share of glory. The reverse had no appreciable effect on the general course of the campaign, for it merely put a stop to a movement which Lord Cornwallis subsequently demonstrated to be strategically unsound. In December of the same year Newport was occupied by Clinton under escort of Sir Peter Parker in a small squadron of frigates.

When the British army moved on Philadelphia in 1777 a portion of the fleet, now under Lord Howe, aided in its transportation to the head of the Chesapeake, while another portion

ascended the Delaware, to be followed shortly by Lord Howe in person. The fortifications and obstructions in the river below Philadelphia were reduced and overcome at the price of considerable loss in ships and men—a loss that was more than counterbalanced by our own disasters, elsewhere mentioned.

How seriously was regarded the naval task assumed by England on our coast is shown in the statement at this time by the First Lord of the Admiralty that "in America there were ninety-three ships and vessels of war, of which six were of the line" (Beatson, IV, 291). It naturally suggests itself that the all-important purpose of cutting off the colonies from their source of warlike supplies abroad would have been better served had fewer of these ninety-three vessels been employed as an adjunct to the British army and more set to guard the approaches to our ports. That the British naval force was misused was Washington's firm opinion, confirmed by an episode immediately following the arrival in Newport of the French squadron under de Ternay.

Eighteen years after this time Nelson, at the battle of the Nile, demonstrated the entire practicability of crushing a fleet at anchor by the rapid and well conceived attack of another fleet under way and entering the roadstead from the sea. A similar opportunity was enjoyed by Admirals Graves and Arbuthnot in 1780. De Ternay lay in Narragansett Bay with the *Duc de Bourgoyne*, 80, the *Neptune* and *Conquérant*, 74's, the *Provídence*, *Eveillé*, *Jason* and *Ardent*, 64's, seven ships of the line and two frigates, the *Surveillante* and *Amazone*. The English admiral appeared off the port on the 21st of July with eleven ships of the line, one of 90 guns, six of 74, three of 64 and one of 50, a force ample to overcome the French vessels had their commanders possessed the energy of Nelson. Besides this possible and most desirable result was the strong military necessity of dealing with Rochambeau before he could effect a junction with Washington, to which end Sir Henry Clinton had embarked a large body of troops in transports at Throg's Neck in the Sound. Unable to make up their minds to risk the passage into Narragansett Bay, Graves and Arbuthnot turned back. Clinton now found how intimate was the connection between the integrity of his over-sea communications and the operations on shore, for Washington had profited by his absence from the city to make a threatening demonstration on New York.

In 1780 a second combined expedition against Charleston resulted more favorably to the enemy. The town was reduced after a long siege, and our navy lost the *Providence*, 28, the *Queen of France*, 28, the *Boston*, 24, the *Ranger*, 18, together with several small vessels.

On the American side the only instance of strategic use of sea power is found in the Penobscot affair, where we failed miserably through neglect of tactical precautions. As this ill-fated attempt illustrates, to an exceptional degree, certain principles of coast defense, it is proper to recite briefly the initial situation and the succeeding events.

The enemy possessed, near what is now known as Castine, a local base for operations in Massachusetts Bay. This post was fairly well fortified and garrisoned. The State of Massachusetts determining to break it up, organized in 1779 a land force of some 1500 men under General Lovell, also a fleet of three colony cruisers and thirteen privateers. To these were added three United States vessels under Captain Dudley Saltonstall. Allen, in his Battles of the British Navy, gives the following as the list of American vessels present at Castine: Eleven ships, viz. one 32-gun frigate, one ship, 22 guns, six of 20 guns, three of 18 guns; seven brigs, one of 18 guns, one of 16, four of 14, and one of 12, together with nineteen transports. After much delay the works were assaulted, but not taken. Reinforcements were sent for. Pending their arrival, Sir George Collier appeared in the offing with the *Rainbow*, 44, *Raisonnable*, 64, *Blonde*, 32, *Virginia*, 32, *Greyhound*, 20, *Camille*, 20, *Galatea*, 20, and *Otter*, 10. A precipitate flight on our side ensued up the river. The *Warren*, 32, *Diligent*, 14, and *Providence*, 12, were run ashore and burned to prevent their falling into the hands of the enemy. The colonial cruisers and privateers either shared the same fate or were captured. The sailors and soldiers that escaped made their toilsome way back to the settlements through the wilderness of Maine after prolonged and severe suffering.

The object of this expedition was in all ways laudable. The existence of such a secondary base within easy reach of our shores was a serious standing threat to our operations as well as a convenient *point d'appui* for the enemy. To destroy such a base and to remove the attending threat were objects that justified the attempt, provided the defense could be assured of either one

of two things: the command of the sea or a strong harbor of refuge close at hand. By the terms of the case the former condition was absent, the enemy being stronger afloat than we were. The latter condition might have been secured after the expedition had successfully made the dash across from Boston. On the other side of the Penobscot River was an excellent anchorage, sheltered behind an island with two entrances, both capable of defense. I may remark that such refuges are indispensable for the weaker fleet in all coast operations. Had Saltonstall devoted a few of the days lost in idle discussion and waiting to making his ships safe in the not improbable event of Collier's arrival, the attack could have been delivered with the comforting reflection that interruption would not, of necessity, imply ruin. It does not seem that the panic manifested by the American naval commander was at all warranted, nor that some show of resistance was not obligatory in view of the very respectable force he had in hand, as exhibited in Allen's list, quoted above. Assuming, for the sake of argument, that Saltonstall's flight was a necessity through the sudden appearance of superior force, all the greater was his duty to provide a suitable refuge. It was this defiance of the dictates of tactics which brought such a crushing blow to our already slender naval power.

Three months before Washington had expressed his views on the subject of this contemplated expedition. They exhibited a sagacity bordering on prescience. Writing to the President of Congress on April 17, 1780, he said: "Circumstanced as we are, I do not see how the attempt can be made with any prospect of success. A naval co-operation seems to be absolutely necessary, and for this we do not possess the means. We have no fleet, and the enemy has a respectable one on the coast, which they can at any moment employ to frustrate our measures. . . . The operating force, I am informed, must depend on supplies of every kind by water. This communication would be liable to be interrupted at the pleasure of the enemy and the situation of the troops would be alarmingly precarious. . . . Indeed, considering the position of these States, a fleet is essential to our system of defenses, and that we have not hitherto suffered more than we have for want of it is to be ascribed to the feeble and injudicious manner in which the enemy have applied the means in their hands during this war" (Sparks' Writings of Washington, vol. VII, p. 21).

The error committed by Congress in not providing for a navy competent to wage serious war was, in a degree, repaired by the fortunate alliance with France, through which we obtained the presence of a French fleet in our waters and of French troops on our soil. Not having done for ourselves what should have been done, if humanly possible, we were obliged to find friends ready and willing to help us. On February 6, 1778, was concluded a treaty of commerce between France and the United States of America, together with a second and secret treaty in which the contracting parties agreed to unite their efforts against their common enemy, England. The news of the open treaty—a recognition of the independence of the colonies—was followed by the recall of the British ambassador at Paris and the outbreak of hostilities. On April 13, 1778, Count d'Estaing sailed from Toulon for America with eleven ships of the line, one of 50 guns, and five frigates. The English at this moment had six 64's and six 50's on our coast, nine of them being at the mouth of the Delaware under the Commander-in-Chief Lord Howe. It was hoped and expected that Howe would be overpowered before he could be relieved. D'Estaing was ordered to attack the English wherever he could do so with advantage. Should Howe be so much strengthened as to possess the superiority, the French fleet was to retire on Boston and thence proceed to the West Indies. D'Estaing spent so unconscionable a time on the passage that Howe was able, after receiving intelligence of the sailing of the Toulon fleet, to take on board the heavy stores and siege train of Clinton's army at Philadelphia, to consume ten days in getting out of the Delaware, hampered by calms, to reach New York, land his soldiers and their impedimenta, station his vessels in the main channel and erect works on shore for defense, before his rival appeared in the offing. D'Estaing touched at Cape May on July 8th, three days after Howe had transported the army from Navesink to the city. He then proceeded to the entrance of New York. A little more celerity on his part and the British fleet would have been caught on the Jersey coast. As it was, the pilots declared the water insufficient for the heavy French men-of-war, d'Estaing was afraid to cross the bar against the pilot's advice, and an earlier battle of the Nile was *not* fought. D'Estaing went first to the southward, then bore up for Newport, where the English destroyed a number of their vessels, 5 frigates and a

sloop, to prevent their falling into his hands. In the meantime the British reinforcements had begun to come in—scattered liners of Byron's command sent out from England and others. Howe with admirable industry and vigor hastened their repairs, put to sea and arrived off Point Judith but twenty-four hours behind d'Estaing. A strong northerly wind springing up that night, the latter left his anchorage and stood out to sea. The next day was passed in fruitless manœuvres on both sides. Then came a heavy gale which dismasted his flagship, damaged some of his other vessels and so discouraged him that he went to Boston, refitted and eventually sailed for Martinique. A more pitiable instance of great power in feeble hands is seldom recorded. Of results, he achieved none directly. The burning and sinking of the British ships in Narragansett Bay and the withdrawal of Sir Henry Clinton from Philadelphia were caused by his movements and not by his fighting, his strategy rather than his tactics.

D'Estaing paid us a brief visit the following year, 1779, on his way back to France. He tried to capture Savannah, then in the hands of the English. This was one of those bits of soldierizing so fascinating to the sailor. It resulted in failure and much loss of life. The French historian Chevalier,* however, remarks: "In spite of the check we suffered, the presence of the French squadron on the coast was not without value to the American cause. The English, ignorant of the point which we proposed to strike, were everywhere on the defensive. General Clinton, fearing that New York would be attacked by land and by sea, concentrated his forces in that city. By his order, Rhode Island was evacuated, and such was the precipitation of the retreat that the Americans found in the place provisions, munitions of war and pieces of artillery which it had been forgotten to spike." The quotation will serve to recall the suggestion already made as to the close relation that existed between the military strategy of the British and the integrity of their over-sea communications. It is proper to remind you that it was during this time that John Paul Jones was harrying her commerce within sight of England's shores.

On the 12th of July, 1780, the Chevalier de Ternay anchored in Narragansett Bay with seven line-of-battle ships and two frigates. Accompanying him were thirty transports carrying six

* Hist. de la Mar. Fran., p. 148.

thousand French troops under the Comte de Rochambeau. This squadron became but a passive menace to the English, for it played no part in active operations during many months, being either closely blockaded or contained by Arbuthnot at Gardiner's Bay. Admiral Rodney, though in command in the West Indies, left his own post to bring a powerful fleet to North America. Here are his reasons in his own words, which deserve quotation if only for the lesson they convey: "Having received certain intelligence by my several correspondents of the arrival of M. de Guichen at Cape François with the French fleet in very bad condition . . . with a certainty of a convoy . . . destined to sail from San Domingo to France under the protection of the French fleet, I had not a doubt but that part of that fleet was intended to reinforce the squadron under M. de Ternay, of whose arrival and taking possession of Rhode Island I had been assured by a captain of an American vessel. As it plainly appeared to me that His Majesty's territories, fleet and army in America were in imminent danger of being overpowered by the superior force of the public enemy, I deemed it a duty incumbent upon me to forego any emoluments that might have accrued to myself by the enterprise intended by General Vaughan and myself, . . . therefore, without a moment's hesitation, I flew with all despatch possible to prevent the enemy's making any impression upon the continent before my arrival there." For this readiness to go without orders to a place where he knew he was needed he received the encomiums of the Admirality. The First Lord, Sandwich, wrote him: "It is impossible for us to have a superior fleet in every part; and unless our commanders-in-chief will take the great line, as you do, and consider the King's whole dominions as under their care, our enemies must find us unprepared somewhere and carry their point against us." In Marshall's Life of Washington we read: "This reinforcement not only disconcerted all the plans of the allies and terminated the sanguine hopes which had been formed at the opening of the campaign, but placed it in the power of the British to project in security further expeditions to the South." Mundy, in his life of Rodney, states that "it appears from a private letter addressed by Washington to a friend at this period that he was in despair at Rodney's appearance on the American coast and at the non-arrival of de Guichen, the co-operation of whose fleet he had long been most anxiously expecting."

On sailing for Barbadoes late in the year, Rodney left with Arbuthnot enough vessels to make him superior to de Ternay.

The presence of the French squadron in Newport brought about a lasting change in England's naval position. From being free to act on the offensive, whenever and wherever it suited her purpose to move, she was at once thrown, in a measure, on the defensive. Whatever else she might undertake, this, at least, was imperative, that a sufficient number of powerful vessels should always lie off Narragansett Bay, or at some convenient anchorage near by, ready to engage on terms of superiority should de Ternay venture out. Gardiner's Bay was the point selected. Situated at the eastern end of Long Island, within easy reach of Newport, offering ample and secure shelter and possessing two channels of exit, one of which would be practicable in any wind, it held out exceptional advantages to the British, of which they were not slow to avail themselves. Accepting the logic of the military situation, Arbuthnot took post in Gardiner's Bay, where the bulk of the British ships of the line were chained until freed by the movements of the French.

Twice during the winter and spring of 1780 and 1781 the latter issued from Narragansett Bay: once but a small detachment towards the south; once in force, quickly followed by Arbuthnot.

The threat embodied in the existence of a French fleet at Newport served later to introduce confusion into the plans of the British Admiral Graves when de Grasse appeared off the coast. Much of the weakness of his measures may be justly attributed to his fear of being worsted in an encounter with de Grasse, who could, unlike Graves, count upon a substantial reinforcement after the action.

It had been the intention of the French government to despatch a second squadron to America and thus to make de Ternay stronger than Arbuthnot, but the close blockade of Brest interfered on the one hand as did Byron's arrival on the other. On the former's death the command devolved temporarily upon Captain des Touches, who succeeded in getting to sea at night in March, 1781, bound to the Chesapeake. His departure was quickly discovered and his destination guessed by the English, who hastened to bar his entrance into that bay, where Arnold was ravaging the country about Richmond and along the James, and whither Lafayette was marching with 1200 Continentals. The two

squadrons had each eight vessels, but the English counted in their line one ninety-gun ship while the French had one heavy frigate. They met off Cape Charles in a running fight, in which des Touches had rather the better of it, although he gave up his purpose and returned to Newport, while Arbuthnot anchored in the Chesapeake. Mahan says, "The way of the sea being thus open and held in force, two thousand more English troops, sailing from New York, reached Virginia on the 26th of March, and the subsequent arrival of Cornwallis in May raised the number to seven thousand" (Mahan, Sea Power, p. 387). By order of Clinton, Cornwallis occupied Yorktown, in which point the chief interest now centered. The combined French and American forces at Yorktown numbered about sixteen thousand. It is evident that Cornwallis' fate depended upon his communication by the sea. That such an elementary proposition should have been misapprehended by Graves, now in principal command of the British fleet on our coast, seems incredible, however true.

In justice to an officer upon whom rests the responsibility of disastrous failure, it is proper to state that at first Graves was misled by information from England into going with six sail of the line and two fifty-gun ships to cruise off George's Bank for the interception of an expected squadron of transports bringing reinforcements of French troops to Rochambeau. During his absence the pregnant news of de Grasse's probable sailing from the West Indies to America arrived in New York. The vessel sent thence to him fell among American privateers and was wrecked on Long Island, while a second despatch-boat carrying the more positive intelligence of de Grasse's actual start and destination was captured *en route*. Graves returned to New York, August 16. There was yet time for an active commander-in-chief to arrange measures by which to profit by the coming of Hood's squadron from the West Indies and to consider what ought to be done in reply to de Grasse's possible attack. Not only did he neglect to take any precautions under this head, but he seriously contemplated a joint expedition to Rhode Island.

Through Graves' return to New York a gap was left open into which de Grasse threw himself with a powerful force from the West Indies. A desultory action took place off the Chesapeake between de Grasse and Graves, of which the only result was to permit de Barras, des Touches' successor, to join de Grasse from

Newport and thus to secure for the latter an unquestioned preponderance. He entered the Chesapeake and completed the investment of Cornwallis, who surrendered on the 19th of October, 1781. On this day the war practically came to an end. Had Graves appreciated the paramount necessity of holding the Chesapeake in rear of Cornwallis, or had he met Hood at Cape Henry with his fourteen ships from Rodney's fleet instead of waiting for him at Sandy Hook, Cornwallis might have been saved.

It is impossible to overestimate the value of de Grasse's share in the great result. Says Mahan: "On the French side de Grasse must be credited with a degree of energy, foresight and determination surprising in view of his failures at other times. The decision to take every ship with him, which made him independent of any failure on the part of de Barras; the passage through the Bahama channel to conceal his movements; the address with which he obtained the money and troops required from the Spanish and French military authorities; the prevision which led him, as early as March 29, shortly after leaving Brest, to write to Rochambeau that American coast pilots should be sent to Cape François; the coolness with which he kept Graves amused until de Barras' squadron had slipped in, are all points worthy of admiration" (Mahan, Sea Power, p. 392). It was in no exaggeration of style that Washington wrote to de Grasse the day after the capitulation: "The surrender of York, from which so great glory and advantage are derived to the allies, and the honor of which belongs to your Excellency, etc." Washington states but the simple truth, the honor of the event does belong to de Grasse.

Mahan says, p. 397: "It must again be affirmed that its (the war's) successful ending, at least at so early a date, was due to the control of the sea—to sea power in the hands of the French and its improper distribution by the English authorities."

No naval event of importance took place during the remainder of hostilities. Raids were effected and single ships were taken, but the war ended at Yorktown. Fitful flames, as from the ruins of a freshly burned dwelling, alone indicated the existence of still smouldering embers. Parliament, in 1782, put a final stop to all offensive operations pending the negotiations of the terms of peace.

We have traced the course of events in a hasty and imperfect

manner, we have witnessed the gradual disappearance of our little navy, we have seen the happy advent at the critical moment of an allied fleet sufficient in numbers and power to compel success. In justice to those upon whom devolved the responsibility of conducting the nation's affairs, we must admit that the necessity of a certain measure of sea power did not continue to be unrecognized. As the war dragged on with its alternation of victory and defeat, the weak point of the British combinations became apparent, so that when the French alliance was effected, Washington, from whose decision there can be no appeal, laid this down as the first clause of his memorandum of concerted action submitted to the Comte de Rochambeau and the Chevalier de Ternay on July 15, 1780:

" 1. In any operation, and under all circumstances, a decisive naval superiority is to be considered as a fundamental principle and the basis upon which every hope of success must ultimately depend."

That the campaign ending in the concentration upon Yorktown was a direct result of an assumed superiority of the French fleet is seen in his letter to Col. Laurens at Paris, dated 9 April, 1781: " On the first notice of the storm, which happened on the 22d of January, and of its effects, I intimated to the French general the possibility and importance of improving the opportunity in an attempt upon Arnold. When I received a more certain account of the total loss of the *Culloden* and the dismasting of the *Bedford*, two 74-gun ships belonging to the British fleet in Gardiner's Bay, I immediately put in motion, under the command of the Marquis de Lafayette, as large a part of my small force here as I could with prudence detach to proceed to the Head of Elk, and, with all expedition, made a proposal to the Count de Rochambeau and the Chevalier Destouches for a co-operation in Virginia with the whole of the fleet of our allies and a part of their land force. . . . It may be declared in a word, that we are at the end of our tether, and that now or never our deliverance must come. While, indeed, how easy it would be to retort the enemy's own game upon them, if it could be made to comport with the general plan of the war to keep a superior fleet always in these seas. . . . "

It is needless to multiply quotations. Washington's correspondence of this period abounds in reiterations of the same plea

for ships. Even after the capture of Yorktown, when other offensive movements were contemplated, he wrote to de Grasse suggesting a plan of further operations and said: "You will have observed that whatever efforts are made by the land armies, the navy must have the casting vote in the present contest." Had such a view prevailed six years before, how different would have been the course of events! Our forefathers learnt wisdom from an experience by which we should profit. It is easy for us, after the lapse of more than a century, and guided by the teaching of the new school in naval thought, of which Captain Mahan is the most brilliant exponent, to survey the war and point out the mistakes made on both sides.

It may be alleged that the poverty of the colonies was an all-sufficient bar to the acquisition of a suitable navy. To this it is difficult to make an answer other than to urge the imperative necessity, as proved by subsequent events, for proper ships under proper organization. At all costs and at all sacrifice they should have been obtained, for upon them ultimately depended our existence as a nation.

The fact is that Congress, at the outset, failed to appreciate the strategic form which the war was inevitably bound to assume. Herein lies a reason, cogent in itself, for the course which was actually adopted. When our public men finally came to a realization of our needs it was too late to repair the fault. Fortunate we were in securing from our friend and ally the means we had neglected to provide for ourselves.

Let us, in conclusion, recapitulate the deductions to be drawn from this study. They are six in number.

1st. A mistaken idea at the inception of hostilities of the ultimate importance of naval power.

2d. As a corollary to the above, a shipbuilding programme wrong in its details and wrong in its extent.

3d. A misuse of our great maritime resources, through which we failed to derive substantial benefit from a superiority in numbers afloat, which were nearly, if not quite, three to one in our favor.

4th. A neglect of tactical precautions in the case of a serious combined expedition.

5th. That the part taken by the sailor was not less important than that taken by the soldier.

6th. The termination of the war by the presence of an adequate naval force.

If these inferences be accepted as correct, it follows, as a broad generalization, that a sufficient navy is to-day of paramount importance to us in coast defense. Possessing it, we need have little fear. Without it, we shall be debarred from acting on the offensive-defensive and must remain content to retire from the sea, abandon our coastwise commerce and seek refuge behind the immobile works erected at the principal ports for their protection against the foreign fleets which a continuance of the old continental policy will assuredly invite to our shores. It is not meant to imply that our navy should rival in numbers that of a possible foe, but it is held and urged that, as our forefathers built sloops and frigates where line-of-battle ships alone would answer, we should profit by their unhappy experience and concentrate our efforts in naval construction on armored vessels until our fleet is strong enough to serve its true purpose, the avoidance of hostilities through its power to act with vigor and effect in the event of war. More than this we do not require, and more than this would be contrary to our traditions as a people who seek only peace with honor.

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THE DEVELOPMENT OF SMOKELESS POWDER.*

By Lieutenant JOHN B. BERNADOU, U. S. Navy.

The systematic development of improved ballistic properties from progressive explosives constitutes one of the most important ordnance problems of the present day. The idea is beginning to gain ground among us that hereafter we must look to the powder, as well as to the gun, in our efforts to increase the rapidity of flight and the penetrative power of projectiles; that we must consider the source of energy at our disposal conjointly with the apparatus whose function it is to convert that energy into useful work.

As long as the art of powder making remained at a standstill—as it practically did for several centuries—while the practices of alchemy, rather than the principles of chemistry, may be said to have controlled the manufacture of all explosives, the best that could be done was to follow the progress of mechanics in efforts to effect ordnance improvement; guns were built and powders were found to fire from them. To-day, however, not only is the composition of powder undergoing modification, but new explosive compounds, whose development is based upon chemical discovery, are coming into general use; the results of investigations into the chemical and physical properties of explosives, systematized and co-ordinated by the methods of mathematical analysis, have so increased our knowledge of ballistics, that designers of ordnance are forced to accept new conditions as factors of prime importance in the attainment of ballistic effect.

* Abstract of lecture delivered before the U. S. Naval War College, July 20, 1897.

For purposes of comparison, the old forms of powder, such as black gunpowder, may be regarded as imperfect mechanical mixtures of particles of the materials of which the powder is composed; the new explosives, as very intimate mixtures of the atoms of those elements from whose union into molecules the substance of the explosive is formed. When the old powder is employed as a fine dust it burns with great speed and violence; when agglomerated into grains * it burns in a slow progressive manner. If the grains of the old powders become disintegrated before they are completely consumed, through effects of heat and gas pressure developed in the bore of the gun, the grains crumble away; pressures become violent and regular progressive combustion ceases to obtain. Similar, but not identical conditions, exist for the new explosives. In the form of dust they burn with exceeding rapidity and great violence; when all the particles are decomposed simultaneously, they detonate; by building them up into dense grains they *may* be made, under favorable conditions, to burn progressively.

It was obvious from the start that many advantages were to be obtained by the substitution of the new explosives for the old as progressive powders. The former burned up completely, leaving no residue. Many of them made no smoke. Other conditions being equal, these two qualities alone would have been sufficient to justify their general adoption. But other conditions were not equal. Up to a few years ago the fact remained that no positive, certain way of making nitro-explosives burn progressively had been found. All known precautions could be observed in the preparation; they could be built up into dense grains with the greatest possible care; yet, every now and then a charge of the powder would detonate; that is, instead of burning progressively, in accordance with the finished form of its grains, it would burn as the dust from which the grains were built up. A gun would be shattered, perhaps a life or two lost, and then all confidence in the new material would disappear, the chosen line of development would be abandoned; no fundamental facts would be left unchallenged to anchor new hopes upon.

Until some way could be found, then, of firing a nitro-com-

*By "grain" is to be understood any regular form, flat strips, rods, cubes, etc.

pound from a gun with positive assurance that detonation would not occur, there could be no change from the old powders to the new. This assurance was obtained by the discovery that nitro-cellulose, colloided and formed into grains of regular size, would in all cases, if ignited in a closed space, burn away in a progressive manner, at a rate proportional to the form and dimensions of the grains and to the conditions of their confinement. Two proofs made the fact that colloids would not detonate certain; first, that the grains of colloid powders that were shot out of the gun without being completely consumed, preserved the original shapes, in reduced dimensions, of the grains of which the powder charge was primarily composed; second, that not tens, nor hundreds, but thousands of rounds of colloid powders, fired in guns or exploded in closed vessels, developed in every case pressures that could be shown to correspond rationally, in accordance with the theory of progressive combustion, to size and form of grains and to dimensions of gun chamber or explosion bomb. To make these facts certain, pressures were carried up beyond the 33,000 lb. limit allowed for cannon; and in explosion bombs to well beyond 100,000 lbs. per square inch.

Now, as the only certain way yet found of avoiding detonation and of assuring progressive combustion is through the colloiding of nitro-cellulose, and as nitro-cellulose alone can be colloided, it follows that we are definitely limited in our choice of material for progressive powders to a certain preparation of nitro-cellulose. It is true that a number of substances, such as nitro-glycerine and nitrates of metallic base, may be distributed in minute particles throughout the body of the colloid, and that immunity from simultaneous detonation may be secured for the particles so distributed; but they all remain uncombined in the colloid; the nitrates as the sand or minute shells in the body of a sponge, the nitro-glycerine as the water in the pores of the sponge. It is desired to emphasize by this comparison the fact that all the new powders, without exception, must be built up from some form of colloid nitro-cellulose, whether they contain other ingredients or not. Thus, in the case of those powders containing nitro-glycerine we may reduce the percentage of nitro-glycerine to zero; that is, we may eliminate it. If we were to remove the colloid nitro-cellulose from such a powder we

would have remaining nitro-glycerine, which would detonate in the gun upon the attempt to fire.

Nitro-cellulose, which is usually prepared by dipping cotton into nitric acid, possesses a property which the cotton, before dipping into acid, does not, *i. e.*, of dissolving in a number of substances. One of these is acetone, a volatile fluid, with a characteristic pungent and aromatic odor, somewhat suggesting common alcohol in appearance and properties. Another solvent for another kind of nitro-cellulose is a mixture of ether and alcohol. If the clear liquids which constitute the solutions in these substances be evaporated, there will be obtained, not the nitrated cotton, in its original fibrous form, but first, a syrupy liquid, then a jelly, and finally, as dryness is approached, a solid translucent mass, varying in color according to the variety of nitro-cellulose from which it is prepared, from a straw yellow to a chocolate brown, and generally suggesting, in its various forms, tortoise shell. To such a substance the appellation *colloid*, from its glue-like consistency, has been applied.

The general name for the material produced by steeping cellulose into nitric acid is nitro-cellulose. One of its common forms is gun cotton. Chemists are well aware that there are many different kinds of nitro-cellulose, but just how many there are no one has as yet even been able to predict, the exact composition of cellulose and of its nitro-derivatives remaining among the yet unsolved mysteries of nature. Three forms were originally assigned to it, the mono-, di- and tri-, just as there were the three forms of mono-, di- and tri-nitro-glycerine. A later investigator (Eder) succeeded in proving the existence of six. The authority of to-day upon the subject, whose views are now generally accepted (Vieille), has formulated eight. Now, just as there are many varieties of nitro-cellulose, so there are many varieties of colloids. The nitro-celluloses themselves all look alike; in their common pulped form they suggest fine white flour. They can be distinguished from one another with ease by the readiness with which some of them go into solution in certain solvents, while others remain undissolved in these solvents like so much sand. The fact that they possess such different properties is accounted for in practice by proven differences in chemical composition. It suffices here to state that there are a number of different varieties of the substance which form a number of

different colloids. The question of composition will be considered later in relation to the gases resulting from the combustion of nitro-compounds.

We are familiar with the kind of nitro-cellulose used for detonating purposes—gun cotton. We are also familiar with a form of colloid in common use to-day as a material. I refer here to celluloid, now very generally employed for the manufacture of a great number of useful articles. The nitro-cellulose from which celluloid is prepared may be made by steeping cotton in weak acids, and is rather a combustible than an explosive; it is a very different substance from the high explosive gun cotton, which is prepared from cotton by the use of strong acids. One solvent used to make celluloid is a mixture of ether and alcohol; the same solvent has no effect upon gun cotton, to dissolve which acetone must be used. We have, then, two different types of colloid to start with—celluloid (formed from weakly nitrated cellulose by the use of ether-alcohol), and the acetone colloid of gun cotton. It may be stated here that these two types of colloids represent all that is important in relation to colloid material for the manufacture of smokeless powder, as the matter has been understood up to a very recent date. The various colloids of the eight varieties of gun cotton above referred to range themselves under one or the other of these two types. We thus have two classes of colloid to experiment with, as gunpowder, and all the information we possess in relation to them is the fact that, however they may burn in the gun, yet they will not detonate.

Suppose that a number of rounds of powder are prepared from the two colloids, how will they act when fired from a gun of a given calibre? Let us assume that we have at our disposal the instruments commonly employed for the measurement of muzzle velocities and of bore pressures, the chronograph and pressure gauges; we will then have, as a basis of comparison, first, the ratios V/P of velocities to pressures*; second, our personal observations of other phenomena attending explosion.

Actual practice shows that the best results obtained for the two powders in a given gun, by varying weights of charge and dimensions of grain, would be about as follows:

*A convenient expression for comparing, in a given gun, the ballistic properties of different progressive powders,—V representing velocities in foot-seconds; and P, pressures in tons per square inch.

Gun cotton-acetone colloid	$V/P = 2100/15\text{-}19$
Celluloid nitro-cotton* colloided with ether-alcohol	$V/P = 2100/16$

Inspection of the results shows the existence of a pressure-range of from fifteen to nineteen tons for the acetone powder; this means that while no detonation would occur, yet that pressures would jump, between certain limits. Such a phenomenon is often observed in the tests of brown powders for heavy guns. A powder of this character would be unsuitable for general use by reason of pressure irregularity.

Upon firing the celluloid powder another and perhaps worse inconvenience would be met with. Considerable smoke would be developed and the interior of the bore would be found lined, after each round, with a heavy coating of soot, which, after one or two shots had been fired and the gun had become heated, would ignite after each succeeding round upon ingress of fresh air on opening of the breech, thereby producing flaming at breech and muzzle.

Obviously, as gunpowder, neither the one nor the other form of colloid is suitable. If they are to be employed they must be improved. Irregularity in pressures from the gun cotton-acetone colloid is due to brittleness; if we are to use this material we must devise some means of toughening it. The celluloid does not contain enough oxygen to consume its substance into gases; to use the latter we must put more oxygen into it.

The original phases of the colloid powder question thus present themselves. Neither the one nor the other form of colloid proving suitable for direct manufacture into powder, people began to try to improve them by combining them, or by adding foreign substances to them. It was well understood that no form of gun cotton, however highly nitrated, contained enough oxygen to effect its own complete combustion—the conversion of its carbon into the higher oxide of carbon, CO_2. The first idea of the experimenter was to add enough oxygen to the nitro-cellulose to thus complete its combustion, and this unfortunate attempt led to many years delay in the development of smokeless powder. It started investigators off upon a wrong track; complete combustion was one thing, and the work necessary to develop highest velocity with lowest bore pressure, another.

* Commonly called "Soluble nitro-cellulose."

With the purpose, then, of improving ballistic qualities of powders by causing them to consume completely and to develop regular pressures, experimenters in different countries began to try the effect of introducing into the colloid various foreign substances,—generally, oxidizing agents, such as nitrates of metallic base,—sometimes, when the mixtures became too violent in their action, a substance rich in carbon, called a deterrent, was added. Such work was a good deal like groping in the dark. There was no method in it. But there was one great incentive to keeping it up, viz., the fact thereby established that the addition of these nitrates to the colloids actually increased the velocity developed for a given bore pressure, whatever the inconveniences attendant upon the employment of these mixtures as powders may have been.*

To establish a comparison between the ballistic efficiencies of the two types of pure colloids above cited and of certain compound colloid powders into whose substance metallic nitrates or other oxygen carriers are incorporated, the following tabular record of performances of powders of these classes is submitted. Note is made therein of objectionable features developed for each of the explosives named.

TABLE I.

A.	B.	C.	D.	E.
Acetone, gun cotton, pure colloid.	Ether-alcohol, soluble nitrocellulose, pure colloid.	K, (primitive type, United States.) Blend of nitrocelluloses colloided in acetone, with metallic nitrates added.	BN, (France, commercial.) Blend of nitrocelluloses colloided in ether-alcohol, with metallic nitrates added.	Cordite, (Great Britain.) Nitro cellulose, colloided in acetone with nitroglycerine added.
$V/P = \frac{2100}{15 \text{ to } 19}$	$V/P = \frac{2100}{16}$	$V/P = \frac{2400}{15}$	$V/P = \frac{2400}{15}$	$V/P = \frac{2400}{15}$
Irregular pressures.	Deposits soot.	Some smoke and bore deposit.	Some smoke and bore deposit.	Erosion; doubtful keeping quality; some smoke.

* The increase in muzzle velocities for a given bore pressure to be attained by incorporating certain amounts of metallic nitrates, nitro-glycerine, etc., into the body of the colloid, constitutes a special phase of development of progressive powders, which will be discussed in a subsequent paper.

Referring to the table we find powders A and B with properties as already described. The K, BN, and cordite all make good ballistic showings, giving velocities greater by about 300 ft. sec. for a developed pressure than the former.

The last line of the table shows that each of the powders possesses certain unfavorable qualities which militate against its adoption for service use. The gun cotton-acetone colloid develops irregular pressures; the ether-alcohol colloid of soluble nitro-cellulose deposits soot; the K and BN produce some smoke and bore deposit. Cordite contains a volatile liquid, nitroglycerine, which develops great heat upon combustion. Now the development of highest velocity at lowest pressure is most important, even if obtained at the expense of the production of certain partially unfavorable conditions; but there was a further incentive to progress at this stage of development—the fact there had been found a form of pure colloid, unadulterated by admixture with other substances, which, while developing high velocities at moderate pressures, possessed the full round of good qualities necessary in a service powder.

The end sought for in the development of gunpowder is the attainment of the capability of delivering most accurately in a given interval of time the greatest number of most powerful blows; this result to be effected with minimum risk to gunners and with least possible injury to gun. Hereby is implied the fulfilment of a number of important independent conditions, no one of which may be overlooked in the effort to successfully accomplish the object sought. These conditions correspond to qualities possessed by a powder, and may be given, with their opposites, a general grouping under headings as follows:

TABLE II.

QUALITIES OF POWDERS.

	(1)	(2)	(3)	(4)	(5)
Positive.	Non-liability to detonation.	Development of minimum heat.	Formation of minimum residue.	Good keeping qualities.	Maximum propulsive effect.
Negative.	Detonation.	Erosion.	Smoke and bore deposit.	Decomposition.	Low value of V/P.

The first condition is of paramount importance and limits us to the employment of a colloid material. The second represents the fact that the greater the heat developed the greater the wearing away of the inner surface of the bore. The third requirement means obviation of bore deposit, which operates to reduce rapidity of fire by necessitating more or less frequent sponging, and to diminish accuracy of practice through the formation of smoke. The fourth requirement, stability, is all-important, when we remember that the ship must carry safely her store of powder for at least a cruise, and for the reason that when powders begin to decompose they lose their homogeneity and crumble—which means an end to regular pressure development.

Let us now take up requirement fifth—the attainment of maximum propulsive effect—and see what it leads to. What causes the expulsion of the projectile from the gun? The expansion of powder gases. What limits our employment of the expansive force of these gases? The attainment of the limiting bore pressure, this limit being commonly set at fifteen tons per square inch. What represents the greatest amount of work in the form of velocity? The greatest amount of gas expansion in the gun behind the projectile.

We desire, then, the greatest amount of gas expansion, but we are limited as to the rate of this expansion; that is, we must not let it develop in the bore a pressure greater than fifteen tons in the gun chamber or upon the interior walls of the piece. This is tantamount to saying that to produce maximum velocity we require the evolution, at a suitable limited rate of expansion, of the greatest possible volume of gas, the expansion of the gas constituting under these conditions the propelling impulse.

It may be stated here that we possess, *within limits*, the power of controlling the rate of combustion of colloid powders by varying certain conditions relating to combustion, the principal of which are (1) the size of the grains of which the charge is composed, (2) the volume of the powder chamber, (3) the length of the bore of the gun, (4) the weight of the projectile. Granting, then, that we possess within limits the capability of controlling the rate of evolution of the powder gases, we are led to the following conclusion: that the best smokeless powder is that stable colloid which, for a given weight of its substance, evolves in the bore of the gun at the most suitable rate of evolution and expan-

sion, the greatest volume of gas, the said evolution being accompanied with the development of the least heat.

We are led by this deduction to regard the action of the powder from a new standpoint. Besides considering what a powder is composed of, we must now consider what gases it is converted into upon decomposition and what volumes of these gases it generates. Most important of all, it leads us to conduct experiments for the purpose of ascertaining what colloid will, for a given weight of its substance, liberate the greatest volume of gases.

Here was one starting point for a series of experimental researches culminating in the discovery of an efficient smokeless powder. Another line of experimental approaches to the same end connected the efforts to toughen the substance of colloid films containing sufficient oxygen to effect their own complete combustion, with a view to the attainment of increased regularity in developed pressures; a third related to the determination of the causes of certain ballistic phenomena hitherto unexplained, *e. g.*, that acetone colloids developed, in some cases, greatly improved ballistic qualities, after the lapses of periods of from six to twelve months from time of manufacture. These several lines of experimental investigation proved in the end to converge towards the attainment of a common result—the development of a special form of nitro-colloid that possessed the toughness and therefore the regularity of burning of celluloid, and that contained enough oxygen to convert its substance, upon ignition, into wholly gaseous products—which the celluloid did not—and that liberated not only the greatest volume of powder gases at the most suitable rate, but the greatest volume of gases that can be evolved by any colloid at any rate of combustion, whether these colloids contained or did not contain nitro-glycerine, metallic nitrates or other substances.

The questions now present themselves: in what ways do we possess the control of kind and amount of gases evolved upon the combustion of nitro-cellulose and of its colloids; how does the constitution of these gases vary; what are they?

It has been already stated that the exact chemical formulae for cellulose and its nitro-derivatives have not yet been written. That for cellulose may be approximately expressed as $C_{6n} H_{10n} O_{5n}$ where n is an undetermined or indeterminate numerical quantity.

When cellulose is steeped in nitric acid or in a mixture of nitric and sulphuric acid, it is converted into the substance whose composition may be expressed as $C_{6n}\ H_{10n-an}\ O_{5n}\ (NO_2)_{an}$. These two expressions

$$C_{6n}\ H_{10n}\ O_{5n}$$
$$C_{6n}\ H_{10n-an}\ O_{5n}\ (NO\ )_{an}$$

may be considered in comparison with one another. Both contain the same quantity of carbon; the amounts present of the other elements are changed by nitration; *an* atoms of hydrogen are displaced by *an* equivalents of a combination of nitrogen and oxygen, (NO_2). This additional oxygen from the NO_2 acts to supply the energy that converts the cellulose into an explosive, and enters into its substance in combination with a certain amount of nitrogen. Why it carries the nitrogen with it we do not know, but it is a chemical fact that it does so—the fact upon which the designation of the new explosives as nitro-derivatives or nitro-explosives is based.

Upon the ignition of the nitro-cellulose or its colloid the nitrogen is set free; the hydrogen combines with its equivalent of oxygen and appears in the air as steam; the remaining oxygen unites with the carbon to form gaseous oxides of carbon. If there be not enough oxygen to consume all the carbon into gas, part of the latter is deposited as soot; this result was obtained in the attempt to employ celluloid as gunpowder. If there is enough oxygen to consume all the carbon into gases, we have, as products of combustion, a mixture of the gaseous oxides of carbon, of which there are two, CO_2 and CO. The property possessed by carbon of combining at high temperatures with intense energy with oxygen, to form gaseous oxides, is the fact upon which the practical development of explosives depends; there are many explosives that contain neither carbon nor oxygen, but with these we have as yet no practical relations in ordnance matters.

It has been stated already that the attempt to obtain what is called complete combustion for nitro-cellulose colloids by incorporating oxidizing agents into them had misled investigators, who confounded the attainment of complete combustion with the development of maximum velocity at lowest pressure. "Complete combustion" means the conversion of all the carbon into the higher oxide of carbon—carbonic acid, CO_2—a dense

gas about 1.9 times as heavy as the air, the formation of which is accompanied with the development of a high degree of heat. The complete combustion of carbon into carbonic acid gas with the corresponding evolution of a great amount of heat is the characteristic of the combustion of nitro-glycerine. The lower oxide of carbon, CO, is a gas much less dense than carbonic acid, possessing a density of about 1.4 times that of air. Suppose that we have a given weight of a compound of carbon and oxygen, with the elements taken in such proportions as to produce, on ignition, complete combustion into carbonic acid gas, CO_2, with the accompanying evolution of a large amount of heat; let us also suppose that we have an equal weight of compound of the same elements in such proportions as to develop, on ignition, the lower oxide of carbon, carbonic oxide, CO; then, the latter compound, developing the lower oxide, would liberate a volume of gas nearly $1.9/1.4 = 1.36$ times greater than the former. The greater heat produced by the formation of the carbonic acid gas would cause the volume of that gas evolved to be the more expanded, but, at the same time, and this is a fact of crucial importance in the present work, the greater heat would cause the gas to be generated at *a more rapid rate*, in fact, at an extremely rapid rate; and what we require is a low, regular rate of gas evolution to prevent our exceeding at any time the set limit of permissible bore pressure.

In our effort to generate from colloid nitro-cellulose the greatest volume of gas at the most gradual rate of expansion, we must seek, then, (1) to avoid the formation of CO_2 when CO may be formed in lieu thereof; (2) to avoid the formation of free carbon; (3) to generate the maximum amount of the lower oxide of carbon. If we give due consideration to the amounts of water and of nitrogen formed simultaneously with the oxides of carbon, we shall find that the form of nitro-cellulose developing the greatest amount of gas at the most suitable rate corresponds to the formula $C_{30}H_{38}(NO_2)_{12}O_{25}$, which breaks up on decomposition into $30\,CO + 19\,H_2O + 12\,N$.

This material is a new type of nitro-cellulose,* developed by

* This special form of nitro-cellulose, which corresponds to a content of nitrogen of 12.44 per cent. and which was first developed in Russia by the eminent chemist, Professor D. Mendeléef, has been independently developed at the Torpedo Station, through the study of effects of variation of times of immersion, temperatures of nitration and of washing, and strength of acids employed in the nitration of cellulose.

experiment to meet ballistic requirements, which contains just enough oxygen to convert its substance into a gaseous body. Its formation from cellulose depends upon strengths of nitric and sulphuric acid, temperatures of reaction and time of immersion of the cellulose in the acids from which the material is prepared. With ether-alcohol it forms a colloid that possesses, on the one hand, the toughness, and therefore the capability of development of regular pressures, of celluloid; and on the other the capability of consuming into wholly gaseous products that characterizes the gun-cotton acetone colloid; while as a powder it develops, with present types of guns, excellent values of V/P of about 2400/16. Briefly, it may be described as a celluloid containing enough oxygen to convert its substance (when it is consumed out of contact with the atmosphere) wholly into gaseous products.

(*To be continued.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL POLICY OF AMERICA AS OUTLINED IN MESSAGES OF THE PRESIDENTS OF THE UNITED STATES, FROM THE BEGINNING TO THE PRESENT DAY.

By Hon. Theodore Roosevelt.

The following references * by Presidents of the United States to the urgent need of the United States possessing a proper Navy, corresponding to the nation's position as a great power, and ready at any time for efficient service in war, could be multiplied a thousand-fold from the speeches and writings of almost all the statesmen who have striven disinterestedly and intelligently for the true honor and greatness of America. By no means all of the references made by the Presidents themselves have been taken. Many of them, such as President Taylor's urgent appeals for the establishment of a retiring list, and pension list, and the improvement of the personnel of the Navy, or the recitals of the glory gained and conferred by the Navy in the war of 1812, and the civil war, are omitted because they do not bear on the problem of the present day, which is further to augment the Navy, both in materiel and personnel, in battleships, in torpedo-boats, in dry docks, in numbers of officers and men.

Fortunately the quality of the ships and guns, and of the officers and men, that we have, is excellent.

The utterances of the Presidents here quoted tell in outline the growth of the Navy. Washington first advocated its formation for reasons which apply now as forcibly as they applied when he wrote, over a century ago. What he said shows well how, on

* Where necessary they are slightly condensed.

this, as on all other questions, the greatest of Americans approached every problem of vital interest to America in a spirit of the broadest patriotism and statesmanship, combined with clear appreciation of the needs of the present and keen insight into the greater needs which the future would develop.

Under the elder Adams the navy which Washington advocated was actually begun, and even in its infancy it accomplished feats of note. The work of building it up was unwisely stopped, and the war of 1812 showed clearly the vital benefits conferred upon the nation by the little Navy which it possessed, and the terrible loss and damage caused by the fact that in size this Navy was but a small fraction of what it should have been. The utterances of Monroe, the younger Adams, and Andrew Jackson, show that the lesson was at least partially learned, and our Navy, though never brought up quite to the standard it should have been in point of size, was, nevertheless, maintained in a condition not wholly out of proportion to the needs and the honor of the nation.

Especial attention should be paid to the third quotation from Andrew Jackson. The victor of New Orleans had that "instinct for the jugular" which is possessed by every great fighter. All that he says applies to the present day, for, as he points out so clearly, the only effective defensive is the offensive; the only way to defend our own seacoast properly is to attack our enemy instead of waiting for him to attack us. It is for this reason that we can not afford to rely purely upon torpedo-boats or upon any kind of mere coast-defense vessels. Though it is of course absolutely necessary to have an abundance of torpedo-boats, we must also possess a powerful fleet of ships able to hold the seas, able to make long voyages, to stand rough weather, and to meet and overcome in the shock of actual fight any enemy's fleet; for it is the enemy's fleet which should be the true objective in naval war. Fortifications are indispensable, but they in no sense equal, or supply the place of, a fighting navy.

The effect of bringing the Navy up to something like a proper standard was shown in the inestimable services it rendered during the civil war. It is characteristic of Lincoln's far-seeing statesmanship and loving care for the welfare, ultimate as well as immediate, of the people for whom he was soon to lay down his life, that in the midst of the iron stress of the civil war, when the

problems of the present would have wholly absorbed any lesser man, he should yet have thought of the future in connection with our Navy, and should have advocated the building of those sea-going battleships which, though not needed in civil strife, would most assuredly be indispensable if the honor and renown of America were to be upheld against foreign powers.

After the close of the civil war there came a period of reaction and decline. In spite of President Grant's repeated warnings and protests, a spirit of unwise economy prevailed, and our Navy was suffered to sink below the level of that of even the third-rate powers. Then, in the middle of President Arthur's administration, the turn came; the people and their representatives awoke to what was demanded by national self-respect, the foundations of our present Navy were laid, and ever since then under every administration the work of building it up has gone steadily on.

In point of efficiency our ships need fear comparison with those of no foreign nation, and though they are not nearly as numerous as they should be, yet long strides in the right direction have been taken. To stop now would be to leave the work half done. But if we continue to build up our Navy for a few years to come, along the lines we have followed for the fifteen years immediately past, we shall, within a comparatively short period, place the United States where she should be, among the naval powers of the world. Such a Navy would be, as all of our great leaders from the days of Washington and the elder Adams to our own have pointed out, the surest guarantee of peace; and if by any unlucky chance we were to have war, it would not merely save us from material disasters, but what is of incalculably more moment, it would prevent that loss of national honor which would be felt as keenly in the farthest interior of the country as on the seaboard of the Atlantic or the Pacific.

THEODORE ROOSEVELT.

GEORGE WASHINGTON.

January 8, 1790.

To be prepared for war is one of the most effectual means of preserving peace.

ANNUAL ADDRESS.

December 7, 1796.

To secure respect to a neutral flag requires a naval force organized and ready to vindicate it from insult or aggression. This may even prevent the necessity of going to war by discouraging belligerent powers from committing such violations of the rights of the neutral party as may, first or last, leave no other option.

These considerations invite the United States to look to the means, and to set about the gradual creation of a navy.

However pacific the general policy of a nation may be, it ought never to be without an adequate stock of military knowledge for emergencies. This lack would impair the energy of its character and hazard its safety or expose it to greater evils when war could not be avoided; besides that, war might often not depend upon its own choice. In proportion as the observance of pacific maxims might exempt a nation from the necessity of practicing the rules of the military art ought to be its care in preserving and transmitting, by proper establishments, the knowledge of that art. The art of war is at once comprehensive and complicated. It demands much previous study, and the possession of it in its most improved and perfect state is always of great moment to the security of a nation.

JOHN ADAMS.

May 16, 1797.

Naval power is the natural defense of the United States.

December 8, 1798.

In demonstrating by our conduct that we do not fear war, for the necessary protection of our rights and honor, we shall give no room to infer that we abandon the desire of peace. Efficient preparation for war can alone insure peace.

The beneficial effects of the small naval armament provided under the acts of the last session are known and acknowledged. Perhaps no country ever experienced more sudden and remarkable advantages from any measure of policy than we have derived from the arming for our maritime protection and defense. We ought without loss of time to lay the foundation for an increase

of our Navy to a size sufficient to guard our coast and protect our trade. Such a naval force would afford the best means of general defense.

December 3, 1799.

A steady perseverance in a system of national defense commensurate with our resources and the situation of our country is an obvious dictate of wisdom; for nothing short of the power of repelling aggressions will secure to our country a rational prospect of escaping the calamities of war or national degradation.

November 27, 1800.

A navy, well organized, must constitute the natural and efficient defense of this country against all foreign hostility.

James Madison.

May 25, 1813.

The brilliant achievements of our infant Navy claim the highest praise and the full recompense provided by Congress.

December 5, 1815.

The signal services which have been rendered by our Navy and the capacities it has developed for successful co-operation in the national defense will give to that portion of the public force its full value in the eyes of Congress. To preserve the ships we now have in a sound state, to complete those already contemplated, to provide amply for prompt augmentations, is dictated by the soundest policy.

James Monroe.

January 30, 1824.

In the late war our whole coast was either invaded or menaced with invasion. There was scarcely an harbor or city on any of our great inlets which could be considered secure. In whatever direction the enemy chose to move with their squadrons and to land their troops, our fortifications, where any existed, presented but little obstacle to them. Their squadrons, in fact, annoyed our whole coast, not of the sea only, but every bay and great river throughout its whole extent. In entering these inlets and sailing up them with a small force the effect was disastrous, since

it never failed to draw out the whole population on each side and to keep it in the field while the squadron remained there. The expense and exposure of the inhabitants and the waste of property may readily be conceived. These occurrences demonstrate clearly that in the wars of other powers we can rely only on force for the protection of our neutral rights, and that in any war in which we may be engaged hereafter with a strong naval power, the expense, waste, and other calamities attending it, considering the vast extent of our maritime frontier, can not fail, unless it be defended by adequate fortifications and a suitable naval force, to correspond with those which were experienced in the late war. Two great objects are therefore to be regarded in the establishment of an adequate naval force: The first, to prevent war so far as it may be practicable; the second, to diminish its calamities when it may be inevitable. No government will be disposed to violate our rights if it knows we have the means and are prepared and resolved to defend them.

JOHN QUINCY ADAMS.

December 6, 1825.

A military marine is the only arm by which our power can be estimated or felt by foreign nations, and the only standing military force which can never be dangerous to our own liberty. A permanent naval peace establishment, adapted to our present condition and adaptable to that gigantic growth with which the nation is advancing in its career, is among the subjects which have already occupied the foresight of the last Congress. Our Navy, commenced upon a scale commensurate with the incipient energies, the scanty resources, and the comparative indigence of our infancy, was even then found adequate to cope with the powers of Barbary and with one of the principal maritime powers of Europe.

At a period of further advancement, but with little accession of strength, it has not only sustained with honor the most unequal of conflicts, but covered itself and our country with unfading glory. But it is only since the close of the late war that by the numbers and force of the ships of which it was composed it could deserve the name of a navy.

December 5, 1826.

We have twelve line-of-battle ships,* twenty frigates, and sloops of war in proportion, which, with a few months of preparation, may present a line of floating fortifications along the whole range of our coast. Combined with a system of fortifications upon the shores themselves, it has placed in our possession the most effective sinews of war and has left us at once an example and a lesson from which our own duties may be inferred. The gradual increase of the Navy was the principle of which the act of 29th April, 1816, was the development. It was the introduction of a system to act upon the character and history of our own country for an indefinite series of ages. It was a declaration of that Congress to their constituents and to posterity that it was the destiny and the duty of the United States to become in regular process of time and by no petty advances a great naval power.

Andrew Jackson.

March 4, 1829.

The increase of our Navy, whose flag has displayed in distant climes our skill in navigation and our fame in arms; the preservation of our forts, arsenals, and dockyards, and the introduction of progressive improvements in the discipline and science of both branches of our military service, are so plainly prescribed by prudence that I should be excused for omitting their mention sooner than for enlarging on their importance.

December 8, 1829.

Constituting, as the Navy does, the best standing security of this country against foreign aggression, it claims the especial

* Relatively to our size, and to the navies of other nations, this was a much larger naval force than we have now; and at the outbreak of the civil war in 1861 we were still relatively more powerful at sea than we are now. As regards men to draw on for manning our ships, we no longer have the great maritime commerce and fishing fleets we then had; but we now have, what we then did not, the men who work on the waters of the Great Lakes, and even of the rivers of the west, on whom we can also draw largely; and though our men must still be seamen to be efficient on board ship, and though they require a longer time than ever to learn their duties as men-of-warsmen, the gap between the seaman and the man ashore is no longer so wide as it was.

attention of Government, and should continue to be cherished as the offspring of our national experience.

March 4, 1837.

No nation, however desirous of peace, can hope to escape occasional collisions with other powers, and the soundest dictates of policy require that we should place ourselves in a position to assert our rights if a resort to force should ever become necessary. Our local situation, our long line of seacoast, indented by numerous bays, with deep rivers opening into the interior, as well as our extended and still increasing commerce, point to the Navy as our natural means of defense. It will in the end be found to be the cheapest and most effectual, and now is the time, in a season of peace, that we can year after year add to its strength without increasing the burdens of the people. It is your true policy, for your Navy will not only protect your rich and flourishing commerce in distant seas, but will enable you to reach and annoy the enemy, *and will give to defense its greatest efficiency by meeting danger at a distance from home.*[1] It is impossible by any line of fortification to guard every point from attack against a hostile force advancing from the ocean and selecting its object, but they are indispensable to protect cities from bombardment, dockyards and naval arsenals from destruction, to give shelter to merchant vessels in time of war and to single ships or weaker squadrons when pressed by superior force. Fortifications of this description can not be too soon completed and armed and placed in a condition of the most perfect preparation. The abundant means we now possess can not be applied in any manner more useful to the country, and when this is done and our naval force sufficiently strengthened we need not fear that any nation will wantonly insult us, or needlessly provoke hostilities. We shall more certainly preserve peace when it is well understood that we are prepared for war.

JOHN TYLER.

December 7, 1841.

Every effort will be made to add to the efficiency of the Navy, and I cannot too strongly urge upon you liberal appropriations

[1] The *italics* are my own.

to that branch of the public service. Our extended and otherwise exposed maritime frontier calls for protection, to the furnishing of which an efficient naval force is indispensable. We look to no foreign conquests, nor do we propose to enter into competition with any other nation for supremacy on the ocean; but it is due not only to the honor but to the security of the people of the United States that no nation should be permitted to invade our waters at pleasure. Parsimony alone would suggest the withholding of the necessary means for the protection of our domestic firesides from invasion and our national honor from disgrace. I would most earnestly recommend the increase and prompt equipment of that gallant Navy which has lighted up every sea with its victories and spread an imperishable glory over the country.

JAMES K. POLK.

December 2, 1845.

Our reliance for protection and defense on the land must be mainly by our citizen soldiers, who will be ever ready, as they ever have been ready in times past, to rush with alacrity at the call of their country to her defense. This description of force, however, can not defend our coast, harbors, and inland seas, nor protect our commerce on the ocean or the lakes. These must be protected by our Navy.

Considering an increased naval force, and especially steam vessels, corresponding with our growth and importance as a nation, and proportioned to the increased and increasing naval power of other nations, of vast importance as regards our safety, and the great and growing interests to be protected by it, I recommend the subject to the favorable consideration of Congress.

ABRAHAM LINCOLN.

December 8, 1863.

The duties devolving on the naval branch of the service during the year, and throughout the whole of this unhappy contest, have been discharged with fidelity and eminent success.

The events of the war give an increased interest and importance to the Navy, which will probably extend beyond the war itself.

The armored vessels in our Navy, completed and in service, or which are under contract and approaching completion, are

believed to exceed in number those of any other power. But while these may be relied upon for harbor defense and coast service, others of greater strength and capacity will be necessary for cruising purposes and to maintain our rightful position on the ocean.

No inconsiderable embarrassment, delay, and public injury have been experienced from the want of Governmental establishments (sufficient in number and adequate in character) for the construction and necessary repair of modern naval vessels. I think it my duty to invite your special attention to this subject. Satisfactory and important as have been the performances of the heroic men of the Navy, they are scarcely more wonderful than the success of our mechanics and artisans in the production of war vessels which have created a new form of naval power.

I commend to your consideration the policy of fostering and training seamen for the naval service.

U. S. Grant.

December 5, 1870.

The appropriations made for the last and current years were evidently intended by Congress, and are sufficient only, to keep the Navy on its present footing by the repairing and refitting of our old ships. This policy must, of course, gradually but surely destroy the Navy. It can hardly be wise statesmanship in a government which represents a country with over five thousand miles of coast line on both oceans, exclusive of Alaska, and containing forty millions of progressive people, with relations of every nature with almost every foreign country, to rest with such inadequate means of enforcing any foreign policy either of protection or redress. Separated by the ocean from the nations of the eastern continent, our Navy is our only means of direct protection to our citizens abroad, or for the enforcement of any foreign policy.

December 2, 1872.

Unless early steps are taken to preserve our Navy, in a very few years the United States will be the weakest nation, upon the ocean, of all great powers. With an energetic, progressive, business people like ours, penetrating and forming business relations with every part of the known world, a Navy strong enough to

command the respect of our flag abroad is necessary for the full protection of all their rights.

December 2, 1873.

The distressing occurrences which have taken place in the waters of the Caribbean Sea, almost on our very seaboard, illustrate most forcibly the necessity always existing, that a nation situated like ours should maintain in a state of possible efficiency a Navy adequate to its responsibilities. Congress [should] provide adequately, not only for the present preparation, but for the future maintenance of our naval force.

Chester A. Arthur.

December 6, 1881.

I can not too strongly urge upon you my conviction that every consideration of national safety, economy, and honor imperatively demands a thorough rehabilitation of our Navy.

With a full appreciation of the fact that this must involve a large expenditure of the public moneys, I earnestly recommend such appropriations as will accomplish an end which seems to me so desirable.

Nothing can be more inconsistent with true public economy than withholding the means necessary to accomplish the objects intrusted by the Constitution to the National Legislature. One of these objects, which is of paramount importance, is declared by our fundamental law to be the provision for the "common defense." Surely nothing is more essential to the defense of the United States and of all our people than the efficiency of our Navy.

If we heed the teachings of history we shall not forget that in the life of every nation emergencies may arise when a resort to arms can alone save it from dishonor.

December 4, 1883.

The work of strengthening our Navy by the construction of modern vessels has been auspiciously begun.

That our naval strength should be made adequate for the defense of our harbors, the protection of our commercial interests, and the maintenance of our national honor is a proposition from which no patriotic citizen can withhold his assent.

December 1, 1884.

I can not too strongly urge the duty of restoring our Navy as rapidly as possible to the high state of efficiency which formerly characterized it. As the long peace that has lulled us into a state of fancied security may at any time be disturbed, it is plain that the policy of strengthening this arm of the service is dictated by considerations of wise economy, of just regard for our future tranquillity, and of true appreciation of the dignity and honor of the Republic.

GROVER CLEVELAND.

December 8, 1885.

All must admit the importance of an effective navy to a nation like ours. Yet we have not a single vessel of war that could keep the seas against a first-class vessel of any important power. Such a condition ought not longer to continue. The nation that can not resist aggression is constantly exposed to it. Its foreign policy is of necessity weak, and its negotiations are conducted with disadvantage because it is not in condition to enforce the terms dictated by its sense of right and justice.

BENJAMIN HARRISON.

December 9, 1891.

When it is recollected that the work of building a modern Navy was only initiated in the year 1883, that our naval constructors and shipbuilders were practically without experience in the construction of large iron and steel ships, that our engine shops were unfamiliar with great marine engines, and that the manufacture of steel forgings for guns and plates was almost wholly a foreign industry, the progress that has been made is not only highly satisfactory, but furnishes the assurance that the United States will before long attain, in the construction of such vessels, with their engines and armaments, the same pre-eminence which it attained when the best instrument of ocean commerce was the clipper ship, and the most impressive exhibit of naval power the old wooden three-decker man-of-war. The officers of the Navy and the proprietors and engineers of our great private shops have responded with wonderful intelligence and professional zeal to the confidence expressed by Congress in its liberal legislation.

There should be no hesitation in promptly completing a Navy of the best modern type, large enough to enable this country to display its flag in all seas for the protection of its citizens and its extending commerce. It is essential to the dignity of this nation and to that peaceful influence which it should exercise on this hemisphere that its Navy should be adequate, both upon the shores of the Atlantic and of the Pacific.

December 6, 1892.

I earnestly express the hope that the work which has made such noble progress may not now be stayed. The wholesome influence for peace and the increased sense of security which our citizens domiciled in other lands feel when these magnificent ships under the American flag appear is already most gratefully apparent. The United States is again a naval power.

[COPYRIGETED.]

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE YACHT "DEFENDER" AND THE USE OF ALUMINUM IN MARINE CONSTRUCTION.

By Richmond Pearson Hobson, Asst. Naval Constructor, U. S. N.

Continued from No. 82.

The features that determine cost in a structure are: first, the cost of production, or first cost; second, the cost of maintenance, or care; third, the length of life.

D.—Comparison for First Cost.

The cost of production, or first cost, is made up of cost of material as supplied by the dealer or manufacturer, cost of labor expended in construction, deterioration of plant entailed, and interest on capital invested. The cost of labor is here taken to include draughting, superintendence, supply of power, etc.

1. Cost of Material.

a. Rolled Material.—The cost of ordinary mild steel used in hull construction may be taken at 2 cents per pound for both plates and shapes.

The cost of aluminum has not reached a steady level, continuing naturally to fall with the increase and improvement in methods of production. Roughly speaking, this increase in production has doubled each year for several years past, and though, for other causes, the fall in price has not been so rapid, it has

been pronounced and must be expected to continue for some time to come.

It is difficult, therefore, to assign to aluminum a definite value, and any value assigned must be considered as only momentary. For the purpose of comparison, however, the cost of rolled aluminum at the present time may be taken at 40 cents per pound for plates and 60 cents per pound for shapes, giving, compared with steel, the ratios per unit weight of 20 and 30 respectively.

(1) *Plates.*—As seen above, the ratio of weights for steel and aluminum in tension is .5 for equal ultimate strength, and .35 for equal elastic strengths. For plates, therefore, the ratios of cost in the two cases are 10 and 7 respectively.

The ratio of weights of plates for equal bending moments is .44 when working to the ultimate limit and .36 when working to the elastic limit. The ratios of costs, therefore, are 8.8 and 7.2 respectively.

The ratio of weight for equal stiffness is .648; the ratio of costs, therefore, is 9.6.

(2) *Shapes* of proportional dimensions.

The ratio of weights for equal bending moments when working to the ultimate limit is .55 for I beams and .58 for angles. The ratios of costs, therefore, are 16 and 17 respectively.

The similar ratios when working to the elastic limit are for weight .37 for I beams and .4 for angles, and for cost 11 for I beams and 12 for angles.

The ratio of weights for equal stiffness is .4 for I beams and .62 for angles. The ratios of costs therefore are 12 and 18 respectively.

b. Cast Material.—It will appear below, if not already evident, that aluminum is unfitted for heavy ship castings, such as stems, sternposts, shaft struts, etc., by nature of its small resistance to unusual violent shocks. The comparison, therefore, need extend only to small castings for fittings.

The cost of cast steel for hull fittings may be taken generally at 10 cents per pound. The cost of cast aluminum for the same fittings may be taken at 60 cents per pound. The ratio of costs, therefore, per unit weight is 6.

In the range of cast hull fittings, the castings and parts of castings serve the function of covering like plates, of stiffness like shapes, and attachments like simple bars. Some castings and

some parts of castings are designed with special regard to ultimate resistance, and others are designed with special regard to elastic resistance. The resistance in some cases is simple, in others compound. Taking a general mean for equality of resistance, the ratio of weight is .48. The ratio of costs therefore is 2.9.

Many cast hull fittings are made sometimes of cast steel, sometimes of cast brass; many are made exclusively of cast brass. It is therefore interesting to note that the comparison of aluminum with brass in these cases would give a ratio of weight of about .3 and of cost about .9. Recalling, too, that the two metals are more or less alike in relative softness and ease of working, it may be said roughly that the aluminum fittings giving the same strength as brass fittings have the same cost, with only one-third the weight.

It should be borne in mind, however, that this comparison, as also the comparisons with steel, assumes a degree of perfection in casting aluminum scarcely warranted at the present moment. It is given, however, in view of the rapid progress being constantly made in the new art of casting aluminum.

2. *Cost of Labor.*

a. For Rolled Material. (1) *Hull work proper.*—For steel the cost of labor in large hull work, plates and shapes may be taken at 4 cents per pound. For aluminum, on account of its newness and limited application, definite figures or results and estimates of the cost of labor in construction are lacking, and, despite of efforts, have not been attainable. The comparisons, therefore, must be limited to a general appreciation only.

The term labor, in estimates of hull construction, includes all operations of transportation and handling in yard and in shops, all operations of preparation of the material, laying off, punching, shearing, planing, bending, flanging, trueing, all operations of adjusting and securing in place, bolting, drilling, riveting.

In operations of transportation, handling and adjusting, the great lightness of aluminum work, less than half the weight of corresponding steel work, permits of marked economy in the number of men and length of time required.

In operations of tool work, planing, shearing, chipping, drilling,

etc., the greater softness of aluminum insures a similar marked economy. The same feature of softness gives a marked economy in riveting, all work being riveted cold, doing away with the portable forges and reducing the number of the riveting gangs.

On the other hand, the greater elastic elongation and the immensely smaller ultimate elongation of aluminum cause the operation of shaping, rolling, bending, flanging plates, bending and trueing shapes to be more difficult and more delicate, requiring longer time and greater skill. This drawback, evidently, is much more pronounced for shapes than for plates, the operation of trueing under the beam set involving, indeed, danger of destroying the integrity of the shapes.

The relative importance or amount of labor in these various operations depends evidently on the nature of the piece of work. Taking hull work throughout, and considering all the operations involved, the advantage sets emphatically to the side of aluminum in the case of plates, but is probably against aluminum in the case of shapes.

For the sake of continuing the numerical comparison, the advantage of aluminum over steel for plates is estimated at 25 per cent., while the advantage of steel over aluminum for shapes will be taken at the same figure. These figures, however, must be regarded as results of inductive judgment only.

Thus for aluminum the cost of labor in large hull work is taken for plates at three-fourths and for shapes at five-fourths the cost of steel for the same work.

Taking the weight ratios roughly at one-half, the cost of labor becomes for plate work 6 cents per pound and for shapes 10 cents per pound.

(2) *Hull fittings.*—For rolled steel the cost of labor in hull fittings may be taken broadly at 20 cents per pound.

The observations on the comparison for hull work hold in general for hull fittings. The operations of transportation and handling, however, become of less consequence, reducing the advantage of aluminum. On the other hand, the operations of shaping and trueing become likewise of less consequence, while the operations of small tool work, chipping, drilling, etc., become more pronounced in favor of aluminum. For the present purpose, therefore, the price ratio may be taken at three-quarters for shapes as well as plates; with the same weight ratio, the cost of labor for aluminum hull fittings becomes 30 cents per pound.

b. For Cast Material.—Confining the comparison, for the same reason as given above, to small castings for hull fittings, the cost of labor for steel castings may be taken broadly at 12 cents per pound. The cost of labor for aluminum castings for the same fittings may be taken at 16 cents per pound, giving a cost ratio of about two-thirds, using the same weight ratio of one-half.

3. *Other Costs.*

All other costs, including deterioration of plant, interest on capital invested, shop expense, supply of power, draughting, superintendence, etc., may be grouped together. For steel work the cost of the whole group may be taken at 25 per cent. of the cost of labor, in which the allowance for deterioration of plant is taken at about 10 per cent. per year and the interest on capital invested at about 10 per cent. per year.

For aluminum, it is evident that the lightness and softness will materially reduce the cost of deterioration of plant and shop expense, requiring less power, with less strain on machines, and less usure and dressing of tools. The group cost may be taken at four-fifths the cost for steel work.

These rates give the following results:

For Rolled Material.

	Cost of Labor.	Group Cost.
For steel hull work, plates and shapes.....	4c. per lb.	1c. per lb.
For aluminum hull work, plates.....	6c. " "	1.6c. " "
For aluminum hull work, shapes.....	10c. " "	2c. " "
For steel hull fittings, plates and shapes.....	20c. " "	5c. " "
For aluminum hull fittings, plates and shapes.	30c. " "	8c. " "

For Cast Material.

For steel hull fittings	12c. per lb.	3c. per lb.
For aluminum hull fittings.....	16c. " "	4.8c. " "

4. *Summation for First Cost.*

The results thus found for the elements making up first cost are assembled in the following table:

First Cost, Cents Per Lb.

	Steel.				Aluminum.				Weight Ratio Aluminum to Steel.	Cost Ratio Aluminum to Steel.
	Material.	Labor.	Other costs.	Total.	Material.	Labor.	Other costs.	Total.		
For Hull Work:										
Plates	2	4	1	7	40	6	1.6	47.6	.43	2.83
Shapes	2	4	1	7	60	10	2	72	.48	4.98
For Hull Fittings:										
Plate work.	2	20	5	27	40	30	8	78	.43	1.24
Shapes	2	20	5	27	60	30	8	98	.48	1.74
Cast fittings	10	12	3	25	60	16	4.8	80.8	.46	1.48

The striking feature of this table is the reduced ratio of total costs, due to the fact that cost of material in which steel has so heavy an advantage is but one item, while cost of labor and other costs are items of much greater consequence, in which the advantage is slightly on the side of aluminum.

These results are specially pointed out in connection with the applications below, but attention may be called at once to the uniformly small weight ratio, a saving of over one-half in weight, and the comparatively small cost ratio for hull fittings and small castings, and to the marked difference of cost ratio between plates and shapes for hull work, the comparison for first cost thus pointing to the adaptability of aluminum in the following relative order: first, to plate work in hull fittings, with increase over cost of steel work of only 24 per cent.; next, to small castings in hull fittings, with increase of 48 per cent.; next, to shapes in hull fittings, with increase of 74 per cent.; next, to plates in hull work, with 2.8 times the cost of steel; next, to shapes in hull work with 5 times the cost of steel.

E.—Comparison for Cost of Maintenance and Care and Length of Life.

Obstructions have stood in the way of every advance in human industry. Scarcely an advantage has been won without antago-

nism and offsetting disadvantage. When, therefore, not many years since, the industrial world, wrestling with steel and iron, saw aluminum appear above the horizon as a commercial article, promising the great desideratum of strength without the penalty of weight and excessive hardness, it felt a thrill, and the more impetuous, foreseeing correctly the inevitable reduction of cost, thought that man had come into a new province without the strife of conquest, proclaiming in effect an abdication by terrestrial nature of her inexorable law of struggle.

The marine engineer and architect felt the elation above all others, for weight in construction material is the Goliath of their enemies. Only prudence and conservatism interposed to prevent precipitate application of the new metal. The conservative asked if aluminum was in truth a fully constituted David. The first reconnaissance showed an obstacle in the road, of huge proportions, not to be removed by the hand of a boy or the aim of a sling. Salt water and salt air were found to attack and disintegrate the metal.

Three notable cases of aluminum construction followed each other in rapid succession, the Vendenesse, built in France in 1892 and 1893, the Foudre, built in England in 1893 and 1894, and the Defender, built in the United States in 1894 and 1895. All three of these craft more than realized the expectations of performance, but all of them have demonstrated the weak point of aluminum. All have been exposed in varying conditions to the corroding action of salt air and salt water, and have contributed to the knowledge of this unfortunate phenomenon.

The Vendenesse, sloop-rigged sailing yacht, built at St. Denis, has her shell plating, decks and bulkheads of aluminum, 6 per cent. copper alloy, while her frames, keel and stringers are of steel, the weight of hull by this disposition being but 18 per cent. of the displacement.

Shortly after launching in December, 1893, she was dropped down to Havre, and lay in the salt water basin for about four months without attention. Her water line showing signs of corrosion, she was docked and her bottom was found bare with the paint off about 200 square metres of surface, part of the paint at least having been scraped off by obstacles while coming down the Seine. Examination showed corrosion wherever the metal was exposed, pitting being particularly pronounced around the edges of bare spots.

An investigation as to the causes of such pronounced results in so short a time showed, however, that part of the corrosion was undoubtedly due to galvanic action that set in from the proximity of a schooner with copper bottom, and, moreover, the basin received sewer discharges and had imperfect renewal of water.

The subsequent history of the yacht showed conclusively, however, that the metal would be attacked whenever exposed. It showed also practically continuous slow galvanic action, even between plates, both of which were of aluminum. The joints swelled and strained the rivets. One plate only would be corroded, showing lack of homogeneity and the existence of a voltaic circuit.

The deck plating was irregularly attacked; plates here and there had to be removed. The linoleum covering gave partial protection, but not immunity.

The excellent nautical qualities and the mechanical behavior of the metal made the yacht a decided success, but it was found that a specially prepared paint had to be used and that special care and almost constant attention were still necessary for even imperfect preservation.

The Foudre, second-class torpedo-boat, 60 feet long, 9 feet 3 inches beam, 4 foot draft, built by Yarrow for the French Government, and intended for the torpedo cruiser Foudre, is built practically throughout hull and hull fittings of aluminum, worked cold, realizing a saving of about 2½ tons, equal to about half the weight of hull, and about 25 per cent. the weight of total boat.

The stem and sternpost are of galvanized steel; the rivets, where exposed to bilge water, were of iron, elsewhere they were of aluminum; the inner tube of smoke stack and deck plating around smoke stack exposed to heat and a small part of the deck where special strength are required, are of steel. The propeller is of aluminum bronze.

The bottom and inside throughout were painted with red lead and the deck was covered with rubber canvas glued on. After successful trials in the fall of 1895, on which the speed realized was 1¾ knots in excess of contract speed, the boat was taken to Cherbourg and left at moorings all winter, apparently without being visited.

When examined the following spring, corrosion was found to be practically general. The outside of hull was pitted wherever exposed, and the inside was corroded practically throughout. Conning tower and hull fittings, exposed only to the salt air, were likewise uniformly corroded wherever uncovered, though the rubber canvas was effective in preserving the deck.

The result showed that red lead favored and produced corrosion. Moreover, when once begun, corrosion continues unless the metal is thoroughly scraped and cleaned before painting again. To clean the parts thoroughly would have required taking the boat to pieces, so general was the corrosion. The interesting little craft, so unfortunately treated, was practically given over to inevitable disintegration. The five sister boats, first ordered of aluminum, were changed to steel, and the torpedo cruiser was converted to an ordinary first-class cruiser, though it does not necessarily follow that this conversion was due alone to the failure of the aluminum boat.

Referring to the method of construction of Defender, given above, it will be recalled that the top side plating, deck beams, deck strapping, and upper fittings are of aluminum, 4 per cent. nickel alloy, the bottom plating is of bronze, and the stem, frames, floor plates and stiffening angles, bilge stringers, inverted angle bulbs under deck beams, the two deck beams enclosing mast, tie plates around mast, stepping socket, bed plate fittings and supports and chain plates are of steel, while the rivets are of bronze, making thus an intimate association of the three metals.

After completion afloat at Bristol in July, 1895, Defender was taken to New Rochelle. Examined there, the aluminum topsides were found to be in bad condition, with paint off in patches, particularly along water line, showing signs of corrosion along the seam of juncture of bronze and aluminum.

She was docked, washed, sand-papered and painted, and was similarly treated three times more before leaving for the races in September, on each of which occasions there were evidences of corrosion wherever the aluminum and bronze were in contact, and, to a less degree, wherever aluminum was water-washed.

Returning to New Rochelle after the races she was next examined in January, 1896, and was found to be corroded practically all over, corrosion being found underneath the paint, even

where it appeared solid. The inside, too, was slightly corroded all over, with severe corrosion in closets.

She was scraped throughout, washed with benzine and given four coats of paint on the outside and two coats on the inside. It may be recalled, in referring to painting, that the bronze surface of bottom is left bare.

The next examination, five months later, in June, showed corrosion at the water line, along the seam of juncture of aluminum and bronze and around rivet heads, a few rivet heads having fallen off, also corrosion around the chain plates, apparently due to leakage from deck. Corroded parts were scraped and touched up and deck leaks stopped.

The above examinations were made by the care-taker of the yacht, from whose log record the information is taken.

Two months later, in August, as previously referred to, an inspection was made by the writer, and the results, as above given, were fully confirmed.

It was found, in addition, that the cast fittings on deck, such as deck light frames, exposed on the whole to spray and salt air only, were in the last stages of consumption, and in many cases the spongy, honeycombed metal could be broken and crumbled with the hand. On the outside along the seam of juncture of aluminum and bronze, a close inspection showed a series of small mounds for practically the whole length. Upon puncture these mounds were found to be raised by the gray powder of corroded aluminum. On the inside this gray powder of corrosion covered the ledge formed by the top of the inside plating, the system being, as seen above, the raised and sunken system, and by jarring the sides more powder would sift down, showing a general process of corrosion.

Additional rivet heads were found fallen off and an examination of the fracture showed the force of rupture to be mechanical, there being nothing more than usual verdigris on the surface. The only way to account for this breaking off of rivet heads is the supposition of strains set up by the swelling due to the corrosion of the plates connected, combined with the slight elongation capable of being sustained by bronze. This swelling, as seen above, was found on the Vendenesse, and, moreover, appears inevitable when it is recalled that the process of corrosion forms a less compact substance, more bulky, than the metal.

Down from around a number of rivet heads and from the edges of the chain plates extended the yellow-brown streaks of iron corrosion. The steel frames and other steel work are being corroded by the bronze rivets and plates. The vessel presents undoubtedly a series, a network, of voltaic circuits, and it would be interesting to have a galvanometric survey.

Thus in Defender, too, we see a full realization of all the mechanical advantages sought in aluminum, and full satisfaction of behavior under stress of service; but we see too upon her the doom of a short life. In her system are working the fatal germs of the phthisis of corrosion.

Besides the three notable cases of the Vendenesse, Foudre and Defender, there have been others in which aluminum has been used to a greater or less extent, furnishing additional experience on preservation and length of life.

The Forban, first-class torpedo-boat, built for the French Government in 1893 and 1894, by Normand, at Havre, had her low pressure pistons and piston valves and her conning tower, galley, framing for turntables, torpedo tubes and other fittings of aluminum, realizing a saving in weight of about a ton. The results were unsatisfactory for all of these parts and fittings; the piston and valves did not meet the requirements for strength, though it should be recalled, as stated above, that even a comparatively low temperature must be expected to effect the strength of aluminum; the parts and fittings on deck within 12 months gave bad results of corrosion, flaking off in parts, notwithstanding care in painting. The result was that Normand abandoned the use of the metal.

On the torpedo-boats built at the New York Navy Yard and intended for the Maine, a number of cast fittings, principally on deck, such as stanchions, sockets, deck light frames, etc., were first made of aluminum. The metal exhibited brittleness and showed signs of corrosion, and in consequence was abandoned, though it should be stated that measures to prevent corrosion were not attempted.

Some of these fittings left exposed longer to sea air were entirely disintegrated, becoming spongy and flaky, and crumbling to gray powder as found in deck fittings of Defender described above.

Other craft have been built wholly or in part of aluminum,

but have not furnished data, yet attainable, on the corrosive behavior of the metal.

A twenty-three foot electric launch, of 8-knot speed, of about three thousand one hundred pounds displacement, built at Toulon for the service of the Navy Yard, is practically aluminum throughout—plating, stem and sternpost, frames, rivets, etc., realizing the remarkably small hull weight of 346 pounds, or one-ninth of the displacement, the plates being but .078" thick. The aluminum is 6 per cent. copper alloy. This little craft has been in use some time, and has probably evinced interesting features as to corrosion, complicated in all probability by the presence of the storage battery and motor for propelling, but information is not to hand as to results.

Another interesting craft, which in due time will probably give valuable information on the subject of the preservation of aluminum, has recently been built at Nyack on Hudson, a forty-foot launch, designed to develop 200 horse-power and exhibit a very high speed; designer, Chas. D. Mosher; owner, P. Magown, Esq.

This launch has her frames, bilge stringers, keelson, and deck beams of aluminum, the planking being mahogany and keel oak. Adequate measures have been taken in advance with a view to prevent or reduce corrosion. The aluminum is not in contact with copper or other corroding metals; it is nickel alloy, which alloy, as will be seen below, offers better resistance to corrosion than copper alloy, and is coated with 4 coats of special enamel.

The results of behavior under conditions of service will doubtless be valuable.

It may be mentioned here that a number of other craft have been built of aluminum for service in Africa and Madagascar, about twenty-five in all, many of which are built in sections for transportation on the backs of pack animals and couriers. Some of these craft have been in service for a number of years, the Etienne and Davoust being among the pioneers.

No returns have come as to behavior. They doubtless serve their purpose with efficiency, but, navigating fresh water, cannot furnish information of value on the question of corrosion, for, as seen below, aluminum has been found to resist effectually the action of fresh water. It is only salt water and salt air that assail it so disastrously.

The weight of experience, as thus seen above, sets against

aluminum. While the object sought in saving of weight was fully realized in each instance, and the mechanical behavior has been satisfactory in every respect, the metal has proved a uniform failure on account of galloping corrosion. When examined more closely, however, the results appear far from conclusive. In the case of the Vendenesse and Foudre the material was a copper alloy. Copper is far removed from aluminum in the electro-chemical scale, and should be expected to make an alloy specially liable to galvanic action; indeed the combination in the alloy itself practically contains the elements of a battery. As a matter of fact, the copper alloy, which offers but very slight, if any, advantage for resistance over other alloys, such as nickel, is the most corrosive of all, the zinc alloy perhaps excepted. Moreover, the paint put on the Foudre to protect it was itself an active agent of corrosion, and both vessels were exposed to conditions that would be severe for a steel hull. It is reported that the special paint used on the Vendenesse in three coats, the first coat having special properties against corrosion, the second against permeability of water, the third against fouling, has given results more or less satisfactory.

In the case of the Defender, while the nickel alloy is used solely perhaps for its physical properties, it is in direct and most intimate contact with bronze, no effort at insulation of any kind whatsoever being made, not even simple precautions that would have been insisted on in an ordinary case of steel and bronze construction. The yacht was built for one sole purpose—to win one series of races—and features not bearing upon that purpose were altogether ignored.

It is evident thus, that the case against aluminum is not complete, and the abandonment by the different governments of its further use in marine construction as a result of the excessive corrosion in the cases tried—this action, while conservative, and perhaps for the moment simply cautious—is by no means final.

The case is one that eminently calls for thorough scientific investigation and experiment, covering the range of alloys and the range of paints or preparations, those now existing and new ones that suggest themselves.

Partial and isolated experiments have already been made.

In connection with the decision to use aluminum for certain fittings for the torpedo-boats intended for the Maine, referred to above, and in connection with a proposition to introduce the general use of aluminum for hull fittings in naval vessels, tests

were made by the Naval Constructor at the Norfolk Navy Yard to determine the resistance to corrosion and fouling.

Two plates, 12" x 18" x $\frac{1}{16}$", furnished by the Pittsburgh Reduction Co., one of pure aluminum, the other of nickel alloy, were immersed with metal bare for three months in tideway water. When taken out in October, 1894, the nickel alloy plate was reported to be thickly covered with small barnacles and very considerably wasted away and corroded, and the pure aluminum plate was reported as "more thickly covered with larger barnacles and slightly pitted throughout its surface."

In January following another test was made.

Two plates were used, 14" x 16" x $\frac{1}{8}$", furnished by the Pittsburgh Reduction Co., one of pure aluminum, the other of 6 per cent. copper alloy. Both plates were immersed with metal bare for 136 days, being taken out for examination after 40 days, and remaining out for 8 days, being cleaned before reimmersion. When finally taken out the pure aluminum plate was reported as showing no signs of corrosion beyond a few small pits, and was only "very slightly fouled" with a "few small barnacles." The copper alloy plate, on the contrary, was reported as "covered with a quantity of small barnacles," "badly fouled and pitted over its entire surface."

These tests, in their limited extent, would indicate that the bare metal of both the copper and nickel alloy is subject to corrosion and fouling in sea water, and that the pure aluminum, commercially pure, was subject but very slightly to corrosion. On the fouling of pure aluminum the results are more or less contradictory, and would indicate a difference of material in the two cases, though indicating that the commercially pure metal is subject to fouling. The exact degree or rapidity of corrosion was not determined, and it would be difficult to compare same with the results for steel under similar conditions.

The above limited experiments confined to bare metal are, it appears, the only ones that have been made in this country under Government directions.

Private tests have been made, however, extending to the behavior of the metal when coated with preventatives of corrosion.

The most extensive of these tests were undertaken by Edward Smith & Co., of New York City, and conducted under the direction of Professor A. H. Sabin, the aluminum plates being furnished by the Pittsburgh Reduction Co.

The scope of the tests covered five different kinds or series of plates and six different coatings for each kind, making thirty plates in all.

The plates, carried horizontally, supported by the four corners in a rack, with about 2" between plates, were immersed in the waters of the New York Navy Yard for six months.

The tests were described in a paper read by Professor Sabin before the American Society of Civil Engineers, contained in the Proceedings of the Society, vol. xxii, No. 7, September, 1896.

The composition of the plates, the nature of the coatings, and the results were as follows, as given in the paper above referred to.

Composition of Plates.

"Series I.—Ninety-nine and one-half per cent. pure aluminum.

Series II.—Ninety-eight per cent. aluminum and 2 per cent. copper.

Series III.—Ninety-eight per cent. aluminum (the quality known as commercially pure aluminum).

Series IV.—Ninety-three per cent. aluminum and 7 per cent. copper.

Series V.—Seventy-five per cent. aluminum, 20 per cent. zinc, 3 per cent. copper, 1 per cent. iron.

These plates were numbered from 101 to 130, and were coated as follows:

I.	II.	III.	IV.	V.	
101	107	113	119	125.....	'Sabin Process' pipe coating enamel, baked.
102	108	114	120	126.....	Durable metal coating, one side baked. Ultramarine blue, one side; flamingo red, one side; ground in varnish, not baked.
104	110	116	122	128.....	White zinc ground in varnish, one side baked.
105	111	117	123	129.....	Chromium oxide ground in varnish, one side baked.
106	112	118	124	130.....	Edward Smith & Co.'s spar varnish, no pigment, one side baked.

The varnish in which the ultramarine blue, flamingo red, white zinc and chromium oxide were ground was composed of 100 pounds Kauri resin to 20 gallons linseed oil, thinned with turpentine. The chromium oxide was the anhydrous oxide made by the ignition method, and was of commercial quality, not chemically pure. The baked coatings were baked about four hours at 215° to 240° F., except that the 'Sabin Process' pipe coating enamel was baked two hours at 400° F."

The condition of each plate after being taken out is given by Mr. Sabin as follows:

Series I.

"101.—Perfect.

102.—Baked side, perfect. Unbaked side, three blisters ¾ inch diameter. No general corrosion or roughening. The surface of the paint had lost its gloss. The coating was good on the edges of the plates.

103.—Ultramarine blue. Showed roughening of coating, numerous pin-head blisters, no corrosion to speak of.

Flamingo red. General condition good, except near edges of plate, which showed blisters over a surface about half an inch wide and one-fifth the marginal distance; very little corrosion.

104.—Baked side. About 2 square inches in one place half covered with small blisters. No corrosion.

Unbaked side. First rate condition.

105.—Baked side, one blister 1 x ½ inch; otherwise first rate. No corrosion. Unbaked side all right.

106.—Both sides perfect.

Series II.

107.—Perfect.

108.—Baked side, one blister ⅜ inch diameter. Unbaked side perfect.

109.—Blue and red about the same as 103, except that about twice as much surface was blistered. General condition good.

110.—Baked side badly blistered in spots along the edges, amounting to about 6 per cent. of the total surface of the plate. Some corrosion under these. Unbaked side all right, except that about 1 per cent. of the surface showed pin-head blisters along a strip about ½ inch wide on one edge of the plate.

111.—Baked side showed four central ¾-inch blisters, num-

erous marginal ones about 1½ per cent. of plate. Very little corrosion. Unbaked side in first rate condition.

112.—Baked side, two central blisters 2 square inches, and nearly all the margin ½ inch wide. Considerable corrosion. Otherwise perfect protection and higher lustre. Unbaked side, two central blisters ½ square inch and 1 square inch. Slight marginal corrosion. Coating evidently thin on edges.

Series III.

113.—At one corner evidently a break in the coating let in water and caused a blister of about 2 square inches. Coating rather overbaked and brittle; elsewhere perfect.

114.—Baked side perfect. Unbaked side tough and adherent, except one small spot near the middle of the plate, which looked as if coating had been broken, and where corrosion had begun.

115.—Blue and red about alike. No decided blisters, but coating itself showed some signs of decomposition, especially the blue, which had a rough surface.

116.—Both sides in good condition, but showed some signs of incipient blistering about the edges.

117.—All right on both sides.

118.—Both sides quite perfect.

Series IV.

119.—At several places about the corners of the plate single blisters, some of which were as large as 3 square inches, had formed. These appeared to be due to the fact that the coating was overbaked and had been cracked at the corners by the supporting framework, and galvanic action had ensued on the penetration of the sea water. This was facilitated by the 7 per cent. of copper in the alloy. The remainder of the plate was perfect.

120.—Baked side showed three blisters of about 1 square inch each and some corrosion under these; otherwise all right. Unbaked side perfect.

121.—Blue and red about alike; about 30 per cent. blistered and corroded.

122.—Pin-head blisters along the edges; general condition all right.

123.—Baked side all right. Unbaked side, seven or eight small blisters, but no corrosion. General condition good.

124.—Both sides badly blistered and corroded along the edge, about 10 per cent. of the surface. Where not blistered, all right.

Series V.

125.—Coating brittle and certainly overbaked. Badly blistered along the edges. In all cases of blisters under pipe coating enamel the blisters were continuous and started from the edge. The middle of the plate was all right.

126.—Baked side badly blistered along the edge—6 per cent. or 8 per cent. affected. Unbaked side slightly blistered, chiefly along one edge; condition otherwise good. No corrosion.

127.—Blue. Considerably blistered along the edges, in pinhead blisters mainly. Little corrosion.

Red. About the same, but some large marginal blisters. The red had a smooth surface, but the blue was rough.

128.—Baked side, nine or ten blisters of some size (1½ inches diameter), and considerable corrosion. Remainder of surface good. Unbaked side, about 1 per cent. of the surface, near the edges, with small blisters showing some corrosion. The rest of the surface all right.

129.—Baked side. A large number of groups (about 1 inch diameter) of small blisters. No corrosion. Unbaked side, about the same, but not so bad.

130.—About like 124.

The pigment mentioned as flamingo red is supposed to be a mixture containing some coloring matter derived from coal tar, and is reasonably permanent in the air. In these tests it became dark and mottled.

The baked surface of those plates which had one side baked were in all cases harder and more glossy than the other sides after the test was made. It should be observed, however, that while these coatings are all at present hard and firm, when they were first taken from the water they were much softer and could be more easily scratched or scraped off, with the exception of the pipe-coating enamel, which was exactly as it was when it was put into the water. Even the lustre was not affected, and the smooth plates coated with it are like a mirror.

On all the plates, except those coated with pipe-coating enamel which was applied by dipping, the coating is much thinner for about an inch along the edges of the plates than it is on the central portions. This fact has been called to the attention of the workmen who painted the plates, and is said to result from the method employed in applying the paint with a brush. In future experiments care will be taken to avoid this. Probably four-fifths of the corrosion occurred along this marginal strip."

The features of these tests, to be noted for the present purpose, are contained in the writer's remarks in the discussion of Professor Sabin's paper, part of which may be given as they were made, as follows:

"Alloys.—The prominent result of the experiments is that which shows that the corrosion increases as the amount of alloy increases, and that copper, as the alloy, particularly accentuates the corrosion. This result is striking in the comparison of the excellent results of Series III, where the alloy was simply 2 per cent. of the commercial impurities, with the unfavorable results of Series II, where the same amount of alloy, 2 per cent., was copper. The interest in this feature is special, for it requires an alloy to develop the best conditions for strength, while among the alloys suited to this purpose, copper, though prominent, is by no means exclusive."

"Coatings.—The experiments, it is noticed, are restricted to varnish and enamel preparations. The favorable results indicate a field for these preparations for the preservation of fittings, if not for hulls.

Interest would attach to comparative tests of these preparations and those used on ships' bottoms, also with special preparations thus far made, and that may be prepared especially for aluminum. A feature that suggests itself from these experiments is that the insulating qualities, as well as the porosity or permeability, may enter to affect results, and there would be interest in determining them in experiments to be made for comparative results. The generally unfavorable results with the baking process would indicate that the process increases the permeability, while the increase of adhesion counts for but little when galvanic action starts beneath. Interest also would attach to determining whether the paints themselves, or any of their components, enter into the phenomena."

"Conditions.—The close proximity of plates of different alloys which varied widely in their galvanic action, affected, in all probability, the results in the individual cases. As far as practicable, while still insuring the same conditions, plates of different alloys should be separated far enough not to affect each other. Even those of the same alloy, having the different coatings, should be arranged so as to affect each other as little as possible.

An analysis should be made as near as can be of the mean sample water of immersion, to determine the special agents, if any, that are present.

If practicable, sets of similar plates and coatings should be tested in different waters and analyses of the water made in each case.

Both coated and uncoated plates of the same and different alloys should be immersed in vessels with sea water of sample kinds, and analyses, qualitative and quantitative, made as follows:

Of the materials of the plates before and after immersion; of the water before and after immersion; of the protecting coatings before and after immersion. These tests should be made progressively, analyses being made at regular intervals.

In addition, the tests should extend to determining the insulating properties of the coatings, and their permeability or porosity, in different thicknesses.

The object of the experiments outlined is apparent. They contemplate, while determining comparative qualities of different alloys and different preparations, to determine the phenomena that take place, and to find each element that enters and the role and relative degree of importance of each."

It is to be regretted that these valuable tests, already extended so largely, covering so large a range of alloys and range of varnishes and enamels, were not still further extended to cover the compositions now used on ships' bottoms, Rahtjen's, McInnis, red lead, etc., for it seems that adequate tests for these compositions have not yet been made.

The care-taker of Defender, Mr. T. S. Mitchell, painter, of New Rochelle, made experiments, as he described orally, in search of a preparation, and found the usual paints all gave bad results. He finally determined on a special paint of his own preparation, which was used exclusively. This is a white paint, apparently a white zinc paint, that tarnishes and streaks badly

under weather, even under the drippings of condensation. Remark may be made of an experiment of Mr. Mitchell's which apparently reproduced the conditions found where the aluminum of Defender laps the bronze. A copper plate was placed on the back of an aluminum plate and put overboard. The result, of course, was a precipitate and destructive attack of the aluminum.

References may be made to a prior experiment with pure aluminum made in this country on the bottom of a wooden sailing vessel plying to the West Indies, where the test was comparative with copper.

The aluminum plate gave .005 in. corrosion where the copper plate gave .007 in. On the other hand the aluminum plate was foul with marine growth, while the copper plate was clean.

Abroad a number of experiments have been made.

In connection with the building of the torpedo-boat Foudre, Mr. A. F. Yarrow carried on a series of experiments, the results of which he describes as follows: "With reference to corrosion from sea water, we have tried a series of experiments, extending over twelve months, and we find, provided there is no galvanic action due to other metals being in contact with aluminum, the corrosion may be taken at under 4 per cent. for aluminum for plates about one-eighth inch thick, the surface being unpainted."*

This rate is not unfavorable in comparison with the usual rate for steel.

As a result of investigations of corrosion incident to the subsequent condition of the Foudre, M. Le Chatelier, Naval Constructor, French Navy, pronounced that aluminum is oxidizable in proportion to its impurities; that salt water affects the aluminum of commerce, but not pure aluminum; that pure aluminum resists oxidation as well as gold and platinum, and is not attacked by nitric and sulphuric acids, though dissolving in alkalies and hydrochloric acid.

M. Besson, Naval Constructor, French Navy, arrived at similar conclusions after investigations in connection with the building of the Davoust for African service, stating that corrodibility diminished as the quantity of copper impurities diminished, pure aluminum being practically incorrodible, the impurities most instru-

*See paper by Mr. Yarrow in the Transactions of the Institution of Naval Architects, vol. xxxvi, 1895.

mental in causing the corrosion being aluminum oxide, iron, carbon and silicon.

M. Guilloux, Naval Constructor, French Navy, designer and superintending constructor for the Vendenesse, who also inspected the Foudre after her corrosion, and who investigated the subject in conjunction with M. Minet, of the Ecole des Arts et Metiers of Paris, found that the usual assemblages of aluminum, taken at random, are liable to create batteries within themselves, and found that the more aluminum is electro-positive the better it resists salt water, and enjoined the following rules in the use of aluminum: 1. Choose aluminum as pure as possible. 2. Have the ingots mixed by fractional fusion to insure homogeneity. 3. Subject the material to galvanometric test and require it to be electro-positive to a piece already tried and found to give satisfactory resistance to corrosion. Take careful precautions during construction. Paint all surfaces and avoid absolutely all contact with copper.

In the paper in which these investigations were described, read before the Association Technique Maritime, which had been preceded by a paper on investigations in connection with the Vendenesse, M. Guilloux stated in conclusion that he regarded the metal as well adapted to marine construction, though delicate and as yet of irregular composition in production, while but slightly understood and insufficiently tried.

Experiments conducted at Neuhausen, Switzerland, in 1895, showed that pure aluminum was not attacked, while they showed that the copper alloys were badly attacked.

In connection with the application of aluminum to uses in the arts and industries ashore, various experiments have been made in the United States and abroad on its resistance to the usual agents that attack metals, noted among which experiments are those conducted by Professor Richards of Lehigh University. The uniform result has been the establishment of the fact that aluminum offers particularly great resistance, except in the case of alkalies and the chlorine group.

The experience in actual service and the experiments made, as outlined above, are inadequate to a definite and final conclusion as to the corrosion of aluminum in salt air and salt water.

The consensus, however, would lead to the following general conclusions:

1. When isolated, pure aluminum is not attacked.

2. When isolated, the usual alloys of aluminum and commercial aluminum are attacked in a measure more or less proportional to the amount or percent of the alloy or impurities. Among the alloys, copper and zinc seem the most corrodible.

3. When in contact or in communication with other metals below it in electro-chemical scale, galvanic action sets in and aluminum and its alloys are rapidly corroded. The action takes place when the contact is between different alloys of aluminum and even between different pieces of the same alloy, when not homogeneous; and there is indication that the corrosion of isolated alloys is probably due, in large measure, to the galvanic action between the particles of the two metals in the body of the alloy. Copper is again the metal whose contact causes most accentuated action, and the copper alloy is the alloy in which galvanic action is most marked.

4. The conditions of corrosion can be ameliorated by the application of coatings and coverings. The usual coatings for iron and steel, however, are not adapted to aluminum, particularly red lead. In case of special coatings, as yet prepared, special care and frequency of application are required. It would seem that the special characteristic to be sought is impermeability.

While drawing the above conclusions on corrosion, the imperfect behavior of steel and iron should be borne in mind. With full appreciation of this imperfection, however, the comparison of the two metals gives the following general results:

1. At the present stage, structural aluminum is materially more subject to corrosion than steel. The marked corrosion, however, must be attributed to galvanic action due to the high electro-positive character of aluminum, the pure metal itself, practically incorrodible, being far ahead of steel, and to this galvanic action must be attributed the corrosion of alloys and the usual commercial aluminum where even there is no external contact with other metals, the action taking place in the body of the metal from the intimate contact of the molecules of aluminum with the molecules of the alloying metals or impurities.

2. This feature of inferiority must therefore be regarded as subject to future amelioration from increase of knowledge and selection in the preparation of the alloys and from improvement

in conditions of insulation and protection. Substantial amelioration has already been found in the use of nickel for the alloy, without entailing loss of strength, while further amelioration seems promised in the use of tungsten for the alloy.

Special measures toward insulation seem not to have been taken or tested in any case.

3. The coatings used for painting steel are not effective in protecting aluminum, and the special coatings as yet prepared are but partially effective, and then only on condition of special care and frequent renewal.

4. This feature of inferiority must likewise be regarded as subject to future amelioration with further experiment and increase of knowledge. It could scarcely be expected to find a suitable coating without research, particularly when the usual coatings for steel are composed so largely of oxides of metals whose contact with aluminum sets up galvanic action.

5. The degree of importance of the inferiority of aluminum to steel in the question of corrosion varies with the conditions of exposure and is disqualifying when the exposure to salt water and spray is constant and where frequent visitation is difficult or impracticable.

The cost of maintenance and care and the length of life identify themselves, as seen above, with the question of corrosion. Without being able, evidently, to assign definite values, the cost of maintenance and care at the present moment must be taken as appreciably greater for aluminum than for steel. The cost of additional care is not of great consequence for parts easily accessible, provided the exposure is not great and the coatings applied or the other process of care are at all effective. For parts constantly exposed multiply the frequency of visitation, the additional cost is considerable, particularly where the parts are difficult of access. In such cases of exposure and difficulty of visitation, the inferior conditions of preservation reduce the length of life, which, under good conditions even, must be considered as shorter than the life of steel. This factor of cost takes on large proportions and, at the present moment, must be considered prohibitory for water-washed surfaces and parts in contact with bilge water, while still of large consequence for all outside parts, topsides, upper works, and upper deck fittings.

F.—Applications.

With the conclusions thus arrived at for cost of maintenance and length of life and the results of calculations for strength, weight and first cost, assembled in the table adjoined, a basis exists for judging between the two metals for adaptability to the various purposes of marine construction. For the present purpose and in keeping with the necessitated method of broad treatment, examination will be limited to salient features only.

1. *Adaptability for shell plating.*

(a). *For plating below water.*

(1). Bottom plating requires, besides elastic strength for structural stresses, special ultimate resistance to dynamic strains incident to grounding or even docking or moving alongside of wharves.

While adequate to the first requirement, aluminum, as seen, is altogether lacking in the second; an aluminum bottom would be penetrated and torn open where a steel bottom would only be deformed without perhaps springing a leak.

A torpedo explosion on the bilge or flank would shatter aluminum plating over a large area, bilging in all probabilities a larger number of compartments.

From considerations of strength, aluminum is thus unadapted for bottom plating of large vessels, unless reinforced by sheathing.

(2). Bottom plating is necessarily in constant exposure to salt water and beyond the reach of visiting except at long intervals when in dry dock. Considerations of corrosion, of care and shortness of life also unfit aluminum for bottom plating of vessels keeping the sea, unless they are sheathed.

Notwithstanding its advantages of lightness, aluminum is therefore doubly barred from use for bottom plating of unsheathed vessels keeping the sea.

(3). The application of sheathing to prevent fouling gives to steel bottoms an excess of resistance to penetration; its application to an aluminum bottom would supply the deficiency of resistance, and at the same time give protection from the contact of sea water.

TABLE OF RATIOS, ALUMINUM TO STEEL.

	STRENGTH.										
	Tension.		Comparison			Bending.				Costs.	
	Elastic.	Ultimate.	Elastic.	Ultimate.	Shearing.	Elastic.	Ultimate.	Stiffness, Flexion.	Weights.	Hull Work.	Hull fittings.
Simple resistance per square inch	.93	.66	.87	.57	.63						
Square Sections, equal tension, elastic	1	....	....	....	....	.96	.63	.38	.36	....	1.0
Square Sections, equal tension, ultimate	....	1	....	....	....	1.6	1.04	.75	.5	....	1.4
Square Sections, compression, elastic	....	....	1	....	....	1.07	.70	.44	.38	....	1.1
Square Sections, compression, ultimate	....	....	....	1	....	2.03	1.33	1.03	.59	...	1.7
Square Sections, shearing	....	....	....	....	1	....	....	....	.53	....	1.5
Square Sections, equal weights	....	....	....	....	....	4.50	2.90	3	1	....	2.8
Rectangular plates, equal tension, elastic	1	....	....	....	....	.99	.65	.41	.36	2.4	1.0
Rectangular plates, equal tension, ultimate	....	1	....	....	....	1.94	1.28	1.13	5	3.3	1.4
Rectangular plates, equal weights	....	....	....	....	....	7.8	5.1	9	1	6.6	2.8
I Beams, proportional dimensions, equal weights	....	....	....	....	....	4.45	2.91	3.08	1	10.4	3.6
I Beams, equal bending moments, elastic	....	....	....	....	....	1	....	.38	.37	3.9	1.4
I Beams, equal bending moments, ultimate	....	....	....	....	....	....	1	.82	.46	4.8	1.7
Angle bars, equal weights	....	....	....	....	....	3.59	2.35	2.3	1	10.4	3.6
Angle bars, equal bending moment elastic	....	....	....	....	....	1	....	.38	.4	4.2	1.5
Angle bars, equal bending moment ultimate	....	....	....	....	....	....	1	.58	.58	6	2.1

Dynamic resistance in tension, elastic, ratio of, per sq. in. .261, weight ratio .33.
" " " " ultimate, ratio very small, approximately inversely proportional to length.

Having a weight ratio of but .43, the aluminum bottom would realize a large saving, amounting in a 9000-ton vessel to about 200 tons, a large fraction of the increase of weight due to sheathing.

The cost ratio being 2.83, the increase of cost in the case considered would be about $90,000, or about 3 per cent. of the total cost of vessel.

A 3 per cent. increase of cost is a small price to pay for a 2 per cent. saving of weight.

The bottom would still be liable to corrosion from the inside, and until experiments have been made with cement and other bilge coverings, it would not be prudent to use aluminum even for sheathed bottoms in the parts where bilge water is liable to collect.

(4). For torpedo-boats and small boats considerations of stiffness determine the scantlings for shell plating. The fiber stress of girder calculation in such cases is less than half the stress admissible. To give the same stiffness, aluminum plates would be 1.34 as thick as steel, making a weight ratio of .48, but the same weight of aluminum plating would realize 9 times the stiffness. For stiffness, therefore, aluminum offers pronounced advantages. In cases of grounding, however, to which such boats are more or less liable in their operations in shoal water, the inferiority of aluminum in dynamic resistance would be in evidence as for the case of large vessels, debarring its use for keel plates and garboards.

When navigating in fresh water and when hauled up, such craft are removed from the corroding effects of salt water and sojourn in these conditions is more or less extended. The conditions of corrosion are therefore materially ameliorated, but would still require a suitable coating or paint of good resisting qualities.

The increase in cost would be similar to the increase in the case of large vessels, not at all prohibitory.

There are therefore material advantages to be gained in the use of aluminum for the bottoms of torpedo-boats and small boats generally, where saving of weight is precious and only the absence of a suitable paint stands in the way of adaptability.

(*b*). *For plating above water.*

(1). In conditions of usual service, plating above water does not require unusual dynamical resistance found necessary for the safety of bottom plating, and the pronounced greater elastic dynamical resistance of aluminum places it perhaps ahead of steel, notwith-

standing the great inferiority in ultimate dynamical resistance. In battle, however, the inferiority of aluminum would again appear in an emphasized form, in the increased wreckage and débris and multiplicity of splinters. The use of aluminum is therefore questionable in wake of gun protection and in the region of unprotected spaces occupied in battle. This is an important factor for unarmored war vessels and is serious for armored vessels, where, notwithstanding isolation of gun positions and the high degree of armor protection, the secondary battery is largely exposed, and fragments and splinters are still a menace.

The conditions of corrosion are severe just above the water line and would exclude aluminum from two or three strakes at least. For the topside above, subjected to intermittent spray and sea, the conditions of corrosion, though much less, are still serious and would require an efficient protecting coating.

The increase in cost is similar to the increase for plating below water and is not commensurate with the similar large gain or saving in weight.

(2). Fragments and splinters in battle do not enter the consideration for torpedo-boats and small boats and for mercantile vessels.

(3). There is therefore an important field for aluminum in plating above water, restricted only by the lack of a suitable coating.

2. *Adaptability for framing.*

Requirements of dynamic resistance exclude aluminum from use in framing behind armor and in general from all association with armor except the support of weight. They affect its use in gun positions and in other spaces occupied in battle where fragments and splinters are to be feared.

For framing elsewhere, however, the nature of its resistance would not incur disadvantage for aluminum, except to a certain extent for outer angles of frames and longitudinals.

Considerations of corrosion are against its use as outer or frame angles in the parts liable to collect bilge water, also as outer angles on longitudinals in the same regions. The conditions for the other parts are also more or less severe.

For the purpose of comparison, assuming the use for all longitudinals and transverse framing below protective deck and for

half the transverse framing above the protective deck, the saving in weight in a 9000-ton vessel of ample freeboard would be about as follows, with weight ratio .48 for shapes and .43 for plates:

Transverse framing below protective deck...					about 58	tons.
In angles and other shapes.....	about	30	tons.			
In platework, floor plates, brackets, gussets, &c.	"	28	"			
In transverse framing above protective deck, angles and other shapes.....				"	13	"
In longitudinal framing				"	45	"
In plates	"	32	"			
In angles	"	13	"			
Total.....					116	"

Total saving about 116 tons. With cost ratio of 2.9 for plates and 5 for shapes, the additional cost would be about $98,000, $69,000 additional for shapes and $29,000 additional for plates.

It is to be noted that the shapes realize only 56 tons of the 116 tons saved, while they entail $69,000 out of $98,000 increase of cost, illustrating the general fact of the smaller advantage to be gained in the use of aluminum for shapes than is to be gained in the use for plates.

In the present case, as pointed out, the outer angles are additionally subjected to severe conditions of corrosion. If therefore these remain of steel, the saving in weight would be about 16 tons less and the increase of cost would be reduced by about $20,000.

Considering the smaller advantage of weight, the larger increase of cost, the severer conditions for corrosion, and the lesser adaptability of resistance, it would appear advantageous to have the outer angles of steel even in the case of the adoption of aluminum for the plates and inner angles.

For these latter plates and angles decided advantage is to be gained in the use of aluminum when a suitable coating is found. Until this time, however, such use would not be prudent in view of the conditions of the double bottom and difficulty of access.

For framing below the protective deck forward and abaft the double bottom, and for framing above the protective deck, where not associated with armor, and where there is no special menace in battle from fragments and splinters, aluminum can be used with advantage in the present stage of progress, provided, as is

assumed throughout, that use is made of an alloy other than copper, and that due attention is paid to preservation.

For torpedo-boats and for small boats generally the conditions of corrosion of frames are not severe, and the frames are more or less accessible, excepting the lower parts of frames of torpedo-boats. The nature of its resistance being suitable, aluminum is therefore adaptable. General adoption for this purpose, however, should also be preceded by experiments to determine the coating best suited for preservation, while it should be borne in mind that the gain in weight of about one-half entails an increase of five times in cost.

3. *Adaptability for inner bottom.*

The nature of aluminum's resistance is suitable for inner bottom plating where the conditions of corrosion are not severe, due regard being taken to the conditions of the underside and the difficulty of access. With a coating of fair efficiency and with due attention, aluminum offers decided advantages for general adoption for inner bottoms. Taking the case of a 9000-ton vessel, the gain in weight with plates of equal stiffness would be about 30 tons, and the increase in cost would be about $16,000.

4. *Adaptability for bulkheads.*

The integrity of bulkheads is undermined as a rule by distortion destroying water-tightness, while rarely, if ever, is the metal called upon to exert its ultimate strength of resistance. The superior stiffness and greater elastic resistance of aluminum mark it therefore for special adaptability for bulkhead purposes, for both plating and stiffeners.

Standing vertically as it does, with ease of access and without exposure of any kind, the conditions for preventing corrosion are peculiarly favorable.

Aluminum therefore is eminently suitable for bulkhead purposes for all classes of vessels.

Taking a vessel of 9000 tons of unusual subdivision and high freeboard, and assuming equal stiffness, the saving of weight and increase of cost are about as follows:

	Weight Saved.	Increased Cost.
Transverse bulkheads below protective deck	45 tons.	$33,000
Transverse bulkheads above protective deck, W. T.	30 "	27,000
Transverse bulkheads above protective deck, light divisional	7 "	5,000
Longitudinal bulkheads below protective deck	96 "	77,000
Longitudinal bulkheads above protective deck	23 "	18,000
Longitudinal bulkheads above protective deck, light divisional	9 "	2,000
	210	$157,000

Total weight saved 210 tons, about 2⅓ per cent. displacement.
Total increase of cost $157,000, about 5 per cent. of total cost.

5. *Adaptability for decks.*

For reasons pointed out above, aluminum is debarred from association with the protective deck. The nature of its resistance, however, is suitable for other decks, both for beams and plating, exception being made for stringers and tieplates, reservation being made also for considerations of fragments and splinters in battle as pointed out above.

For beams, however, with the present conditions of manufacture, the sizes required for large vessels, for which there has yet been no demand, could probably be produced only with increased difficulty, though for the present purpose it will be assumed that they could be produced at the price quoted above for shapes.

Conditions of corrosion would exclude the use for the upper deck unless the plating were covered by wood flat. As a matter of fact such a wood flat is found, as a rule, on the upper deck of war vessels where the deck is of steel. All other decks would require efficient linoleum or other covering on top and an efficient coating on underside. For structural purposes the deck stringers would remain of steel.

For a vessel of 9000 tons, supposing the decks except the protective deck to be of aluminum, both plating and beams, the saving of weight and increase of cost, assuming equal stiffness, would be about as follows:

	Weight Saved.	Increased Cost.
Main deck	about 85 tons.	about $60,000
Gun deck	" 60 "	" 42,000
Berth deck	" 67 "	" 47,000
Platform deck	" 21 "	" 15,000
Flats and floors	" 2 "	" 1,000
	235	$165,000

Total weight saved about 235 tons, about 2⅔ per cent. of total weight.
Total increase of cost about $165,000, about 5½ per cent. of total cost.

6. *Adaptability for other hull work.*

(1). For casings and trunks the same advantageous conditions are offered for aluminum as pointed out in the case of bulkheads. For a 9000-ton vessel the saving in weight would be about 45 tons, about 51 per cent. of the weight in steel, with an increase of cost of about $30,000, about 2⅓ times the cost in steel.

(2). For small trunks and ducts, coaling trunks, ventilator trunks, forced draft ducts, ammunition hoist trunks, chain lockers, blower casings, the same conditions hold; the saving in weight would be about 32 tons, and the increase in cost about $21,000, bearing about the same ratios to total weight and cost in steel as found for casings and trunks.

(3). Similarly for hammock berthing where the saving in weight would be about 14 tons, and the increase in cost about $9000, bearing about the same ratios to total weight and cost in steel.

(4). For metal ceilings inside the same conditions hold, giving a saving of about 6 tons with an increase of cost of about $4000, bearing about the same ratios to total weight and cost in steel.

It should be remarked that the greater conductivity of aluminum would increase the condensation, requiring special provision against same in living spaces.

7. *Adaptability for hull fittings.*

(1). For the ventilating system, the conditions for corrosion are not severe and there are no special requirements for resistance. Aluminum is therefore suited to the air ducts and fittings, and the pipes and cowls, into which forms it can be readily made and is easily worked. On the vessel taken for the comparison the saving in weight would be about 20 tons, with an increase of cost of only about $8000, the cost ratio being taken at 1.24. About 3½ tons are saved in the copper and brass cowls, rims and hoods, without increase of cost.

For the cowls, too, the lighter weight affords greater ease of manipulation for trimming to wind.

(2). For metal doors, water-tight and non-water-tight, the advantages of aluminum are in special evidence. For water-tight doors, the stresses are similar to those of bulkheads, the main consideration being stiffness and resistance to deformation. The distinctive superiority, however, lies in the greater ease of

opening and closing afforded by the lighter weight. On the vessel in question the saving in weight would be about 18 tons and the increase of cost but about $6000. There would be advantage for the substitutions for some wooden doors, as to staterooms, where lightness is also specially desired.

(3). For hatches (other than armored), man-hole covers and frames, the same considerations hold. The saving in weight would be about 11 tons, with an increase in cost of about $4000.

(4). For torpedo ports and coaling ports, the special advantage of ease of handling is again in evidence, though the conditions of corrosion would require an effective coating on the outside. The saving in weight would be about 5 tons and the increase of cost about $2000.

(5). For dead light, air port, and deck light frames and casings, cast aluminum would be well suited provided due attention is given to consideration of corrosion, proper care in selection of material of castings, and application of effective coating. The saving of weight over the brass castings would be about 15 tons without any considerable increase of cost.

(6). For metal ladders and gratings, ease of handling due to lightness gives a distinct advantage, and conditions of corrosion are not severe. The saving of weight would be about 3 tons and increase of cost about $1000. There would also be advantage in many cases in the substitution of aluminum for wood gratings.

(7). For masts and spars the advantage of lightness is in special evidence as reducing high weights, and the conditions of corrosion are not severe. Aluminum is therefore well adapted for usual service where sails are not carried and unusual forces are not to be resisted. It is to be noted, however, that in battle an aluminum lower mast would be more likely to be shattered and drop its charge of military tops, etc. For the lower booms, or boat booms, lightness offers additional advantage for rigging in and out.

The substitution in the case of a vessel carrying two military masts of usual development would be about 14 tons, the increase of cost about $7000.

(8). Among additional miscellaneous fittings for the application of aluminum may be mentioned fresh water tanks, galley outfit, furniture, ammunition boxes, binnacles, lanterns, etc.

Reference has been previously made to the fact of aluminum's

being largely debarred from boiler and engine application on account of the overthrow of its physical properties by heat, even at comparatively low temperature. It should be pointed out, on the other hand, that this obstacle is not incurred in a number of applications in the engine and fire rooms, such for instance as the parquets or floors, envelopes of boilers and condensers, condenser tubes, etc. In connection with the use for condenser tubes it would be necessary to avoid the use of alkalies like soda in cleaning. In the above and in many other applications the lightness of aluminum would be in large advantage, particularly for reciprocating parts. In other applications, to parts of machinery where unusual forces are not to be feared, where the oft repeated forces are well known, the high elastic dynamic resistance would in addition be of decided advantage. For the present purpose, however, this field of application is not investigated.

(9). The above applications, assembled, are as follows:

First, where, at the present stage and under the present condition of manufacture, aluminum could be used to advantage, provided a suitable alloy other than copper is used, and provided due care and attention are given to preservation, as follows:

For Hull work.

	Case of 9000-ton Vessel. Saving in Weight.	Increase in Cost.
Bulkheads	210 tons.	$157,000
Casings and trunks	45 "	30,000
Small trunks and ducts	32 "	21,000
Hammock berthing	14 "	9,000
Metal ceilings	6 "	4,000
Total in hull work	307	$221,000

For Hull fittings.

Ventilation system, ducts, pipes, cowls, and fittings	20 tons.	$8,000
Metal doors	18 "	6,000
Hatches	11 "	4,000
Torpedo ports and coaling ports	5 "	2,000
Metal ladders and gratings	3 "	1,000
Masts and spars	14 "	7,000
Total for hull fittings	71 "	$28,000
Total for hull work	307 "	221,000
Total	378	$249,000

Thus, at the present state of manufacture and with present means of preservation, there could be realized with safety on a vessel of 9000 tons a saving of about 380 tons with an additional expenditure of about $250,000, or an economy of about 4¼ per cent. of the total weight of vessel with about 8⅓ per cent. entailed increase of cost. The relative advantage is most marked in the case of hull fittings, where the saving of weight is about 14 per cent. of total weight of hull fittings, and the entailed increase of cost is only about 8½ per cent. of total cost of hull fittings.

Second, where aluminum can be used with advantage as soon as experiment finds an efficient coating against corrosion, as follows:

For Hull work.

	Case of 9000-ton Vessel. Saving in Weight.	Increase in Cost.
Shell plating.		
Bottom plating of small vessels		
Bottom plating of large vessels when sheathed...	200 tons.	$90,000
Topside plating of small vessels		
Topside plating of large vessels when not associated with armor or armored spaces occupied in battle		
Framing.		
Bottom and topside framing for small vessels....		
Bottom framing except outer angles of transverse frames and longitudinals in double bottom, and topside framing for large vessels.....	100 tons.	$78,000
Inner bottom plating	30 "	16,000
Decks, plating and beams	235 "	165,000
Total for hull work for sheathed vessel....	565	$349,000
Total for hull work for unsheathed vessel..	365	259,000

For Hull fittings.

Dead lights, air ports and deck light frames and casings	15 tons.	000
Total for hull work	365 "	259,000
Total	380	$259,000

Thus, as soon as an efficient preservative coating is found, a further field will be opened up where with a 9000-ton vessel an additional saving of 380 tons could be realized by an increase of cost of about $510,000, or a saving of about 8½ per cent. of total weight and an increase of about 8⅔ per cent. of total cost.

When thus occupying its whole legitimate field in hull construction, the use of aluminum would realize, in a 9000-ton vessel, a saving of weight of about 760 tons with an entailed increase of cost of about $510,000, or a saving of about 8½ per cent. of total weight with an increase of about 17 per cent. of total cost.

It should be recalled that the above results apply to a vessel of war, and for the present purpose it will suffice to point out that for a merchant vessel, where conditions of battle are not taken account of, the application would be larger.

* * * * * * * * *

G.—Summation—Conclusions.

The above comparisons lead to the following results:

Comparison for Strength and Weight.

1. In simple tension, aluminum, which is about ⅓ as heavy as steel, has about ⅔ of the ultimate and about $\frac{14}{15}$ of the elastic resistance.

In simple compression and shearing the ratios are slightly smaller.

2. In bending, aluminum bars of square section having the same weight as steel give about 2.9 times the ultimate strength and about 4.5 times the elastic moment of resistance, and are about 3 times as stiff.

Aluminum plates of equal weight give about 5.1 times the ultimate and about 7.8 times the elastic moment of resistance, and are about 9 times as stiff.

Aluminum shapes of proportioned dimensions of equal weight give for I beams about 2.9 times the ultimate and about 4.5 times the elastic moment and about 3.1 times the stiffness, and for angles about 2.4 times the ultimate and about 3.6 times the elastic moment, and about 2.3 times the stiffness.

3. In elastic elongation, aluminum gives about 2.8 times the elongation of steel with a modulus of elasticity of about ⅓ of steel. For elongation beyond the elastic limit, aluminum is incomparably below steel, the ratio being smaller as the length increases.

The dynamic resistance of aluminum in tension within the elastic limit is, therefore, about 2.6 times the resistance of steel

per unit of cross section, and is about 7.8 times the resistance for equal weight.

Beyond the elastic limit the dynamic resistance of aluminum cannot be compared with the resistance of steel.

Comparison for Cost.

1. To realize the same resistance, plate work in aluminum costs, in general, about 2.8 times as much as steel in hull work and about 1.2 times as much in hull fittings; angle work and work in other shapes cost, in general, about 5 times as much in hull work and about 1.7 times as much in hull fittings.

Cast fittings in aluminum cost about 1.5 times as much as in steel and about the same as in brass.

In all of these cases the weight for aluminum construction is less than half the weight for steel and about ⅓ the weight for brass.

2. The cost of maintenance and care is at present substantially greater for aluminum construction than for steel construction, and increases in proportion to the exposure to corrosion, which becomes exaggerated where conditions favor galvanic action.

3. The length of life of aluminum construction under favorable conditions must be regarded at present as substantially shorter than the length of life of steel construction, on account of pronounced tendency to corrosion. This tendency has been found to be due in most part to galvanic action, largely caused by the alloy or impurities in the metal, an alloy being necessary to realize good results of strength. Of the alloys tried, the copper alloy has given the worst results for corrosion.

As yet a suitable protecting coating has not been found and the field is calling for further scientific experiment.

The cases of the employ of aluminum have been unfortunate in results of corrosion, but they have been incomplete and the conditions, upon examination, have been found to have been extremely severe.

With a properly chosen alloy, like the nickel alloy, and with proper care, aluminum can be safely used where there is not direct exposure to salt water and spray, and the further extent of the advantageous use to fields where the exposure is not specially severe is only held back by the lack of an efficient protective coating.

Applications.

The results of the comparisons for strength and weight and for cost lead to the conclusion that at present aluminum is adapted for use in hull work for bulkheads, casings and trunks, small trunks and ducts, hammock berthing and metal ceiling, and for use in hull fittings for parts of ventilation system, for metal doors, hatches, torpedo ports and coaling ports, metal ladders and gratings, masts and spars, this adoption in the case of a 9000-ton vessel realizing a saving in weight of about 380 tons at an increase of cost of about $250,000.

The same results lead to the conclusion that as soon as an efficient coating is found aluminum will be further adapted for the bottom plating of sheathed vessels, for the bottom and topside plating of small vessels, part of the topside plating of large vessels, for bottom and topside framing of small vessels, for topside framing of large vessels, for the bottom framing of large vessels except outer angles in double bottom, for inner bottom plating, and deck plating, and for dead light, air port and deck light frames and casings, realizing by this adoption in a 9000-ton vessel a saving in weight of about 380 tons at an increase of cost of about $260,000.

It is to be remarked that in the above applications it is assumed that galvanic action does not set in from the contact of aluminum and steel, an assumption apparently justified by experience thus far; but in course of time it is largely probable that appreciable action would set in, if some insulating provision were not made in the joints between the two metals. It is not believed, however, that such insulation provision would be impracticable.

It may be recalled also, as stated in the outset, that performances and homogeneity of aluminum as taken are somewhat ahead of the present stage of manufacture, and that the applications have been extended to dimensions and scantlings not yet commercially turned out.

Moreover, it should not be overlooked that the element of cost in the maintenance and care of aluminum construction and the length of life are not well determined and are difficult to evaluate on account of the limited experience.

The results arrived at are thus to be taken in connection with the limitations necessarily imposed by the fact of the field being essentially new.

In summation, and in conclusion, aluminum has incontestable virtues as a structural material. Its great elastic elongation and resistance within the elastic limit places it far ahead of steel for resisting usual, well determined and repeated dynamic forces, while its great comparative lightness marks it for marine construction. On the other hand it has serious defects. An excessively low elongation beyond the elastic limit unfits it entirely for use where liable to be subjected to violent and unknown dynamic forces; temperatures beyond atmospheric undermine its physical properties; while, notwithstanding an innate superior resistance when pure to the attack of corroding agents, the high position on the electro-chemical scale causing excessive tendency to galvanic action, places a severe obstacle in the way of adoption where exposed to salt water and spray, particularly in the case of alloys, in which form alone the metal exhibits its best physical properties. This last serious defect, however, must be considered as subject to constant amelioration with increase of knowledge and experiment in precautions and higher perfection in manufacture.

Thus, while this new metal has an important field in marine construction, an important field now ready for occupation, and additional fields awaiting only the improvement in conditions for resisting galvanic action, these fields are essentially limited, and the larger domains are shut out by impassable barriers.

The early optimist who inferred all virtues from a single virtue, and the later reactionist who pronounced general unfitness from a few partial trials, were both wide of the mark. The metal is not utopian, but it has nevertheless beyond question an important mission for the serious marine architect, who is only waiting further improvement in manufacture and reduction in cost and further amelioration in conditions of corrosion.

For the naval architect of our own country, for our country itself, the question has a special significance.

The maintenance of a strong commissioned naval force must be our country's policy for taking its destined part of international greatness in regulating the common affairs of the planet, but our position and the spirit of the nation mark our naval policy specially for a great force kept economically in reserve, commissioned only periodically for drill purposes.

In a state of reserve the conditions of corrosion are greatly ameliorated. The vessels seek and lie in fresh water; the torpedo-

boats and small boats, which do not seek fresh water, are hauled up under sheds. Under these conditions the great obstacle of corrosion is largely removed from aluminum's path. Indeed, aluminum appears to be superior to steel in the resistance to the corroding effects of atmospheric exposure and of fresh water.

The question becomes more significant where account is taken of the great natural facilities and possibilities of our coast line for fresh water basins of large expanse for taking vessels of all sizes. It takes on a still more significant aspect when it is recognized that nature in the inland routes along the coast has marked small craft as our great second line of defense, while, in the inland waters of great rivers and great lakes in communication with the sea, she has provided immeasurable possibilities for the construction and maintenance of these craft.

Torpedo-boats which are thus marked for a great natural economical branch of national defense form now the least developed arm of our navy.

There therefore lies ahead, inevitably, a vast programme of torpedo-boat construction, for which every advantage of materials of construction should be earnestly sought. Fortunately for the nation this branch of defense admits of rapid growth and may be expected to have large expansion in the near future. Indeed, the time is not very far distant when, with treaty restrictions abrogated, we shall see on the great lakes, vast flotillas of torpedo-boats, lying for most of the year in economical reserve free from corrosion. Periodically, they will be commissioned for drill purposes, and from time to time will sally forth to the seaboard for mobilization and exercise in the operations of coast defense.

We would realize thus, at a minimum cost and a minimum turning away of the nation's energies from the channels of production, a great power, tranquil in time of peace and good will, irresistible for defense in time of war.

(*Discussions are requested, to be published in No. 84.*)

DISCUSSION.

Torpedoes in Exercise and Battle.

Lieutenant H. C. Poundstone, U. S. Navy.—Part of the data given in the essay is covered in "Notes on Care and Handling." The notes and suggestions on care, handling, adjusting, and practice, already formulated and in manuscript at the Torpedo Station, would, if published for the information and guidance of torpedo officers, be of the greatest assistance. The essay, in a great measure, furnishes a substitute for the notes, etc., referred to, and is a valuable contribution to the literature on the subject of torpedoes and their use. It is to be regretted that the writer did not more closely follow the standard service nomenclature.

I agree thoroughly with the writer as to the necessity for instruction of officers in the mechanism and use of torpedoes, and of more frequent practice to enable officers to gain familiarity and confidence in the use of this weapon; for, as the essayist states, something is learned from each shot, if the conditions and results are fairly analyzed; and the fact that torpedoes exhibit vagaries, apparently inexplicable, should be no bar to their use, for the percentage of hits, within their range, will more than favorably compare with gun fire. The question of cost should be obliterated, not, however, neglecting due precautions in handling, adjusting, etc.

The whole question of torpedo practice, as to adjustments, discharge, dive, set depth, speed, range, deviations, deflections due to speed, and abnormal performances, is in hand at the Torpedo Station for solution, and we shall doubtless soon have the results of practice, up to date, published for the information of the service.

The sections of the essay on "Battle Practice" and "Torpedo Boats and Drill Ground" are well thought out and should have serious consideration.

I congratulate the essayist on a most intelligent comprehension of his subject, and trust that the points to which he calls attention will be taken to heart by the service at large and by those in authority.

Lieutenant R. C. Smith, U. S. Navy.—Lieutenant Ellicott's essay on Torpedoes in Exercise and Battle must strike every reader with its valuable suggestions. A great deal of it could well be embodied in a manual of torpedo instruction for issue to the service. I believe such a work has been begun at the Torpedo Station. At any rate there is much "copy" available in the shape of reports of boards, torpedo-boat officers and others. I recognize a good many points in the essay that exist in that form and that well might be more widely known.

His point in regard to the occasional loss of torpedoes in exercise is certainly well taken. The Indiana has just held a gun practice which must have cost in the neighborhood of $15,000, or approximately the price of four to seven torpedoes according to the Mark. This number

would hardly be lost in a cruise with constant exercise. I do not agree with him that every torpedo in the ship should be used for practice. After many runs all bearings and connections become loose and the accuracy is greatly affected. Each torpedo should be kept carefully adjusted and given a run once or twice a year for verification, but for the ordinary practice I think it would be better to select a few torpedoes from the allowance and use them exclusively. The exercise is more for the practice of the torpedo division than to test the torpedoes, and for this purpose old torpedoes answer perfectly well.

The rules for adjustment on page 418 are those ordinarily given. There is one point that is not generally noticed, and I do not know that it has been formulated; but when once made plain, it aids very much in all the rudder adjustments. In following the rules the natural impulse is to start from forward and work aft through the various connections to the rudder. This is like pouring water through the small end of a funnel. When you reach the rudder you often have to go back and change the corrections already made, as each subsequent correction changes those ahead of it. By reversing the proceeding and adjusting the length of rudder rod first, then the valve star, the locking star and the rest, when you get to the hydrostatic piston the work is finished.

I am in entire accord with Mr. Ellicott's suggestion as to holding torpedo practice at sea in deep water. With the exception of a few cases of "running away," and one of leaving out drain plugs—not counting those of firing with negative buoyancy, which is never necessary—all the accidents I can recall have come from striking bottom or sticking in the mud at the bottom. As far back as 1880 an English board, in considering the desirability of adding a buoyancy apparatus to raise lost torpedoes from the bottom, decided that if the practice was held in deep water, in nine cases out of ten, the torpedoes not being able to strike the bottom, would not be lost.

If the practice must be held in shoal water, it may be desirable to have one or two of the torpedoes fitted with a recovery apparatus. The writer experimented with one at the Torpedo Station a couple of years ago, depending on the release of a buoy and line from the torpedo a few minutes after firing. The experiment went far enough to show the scheme to be feasible. I think the torpedo outfit should include a small air pump and gauge to test for air-tightness, such as is now in use at the Howell testing station; and were I in charge of a plant I should make requisition for one at the earliest moment. The drain holes in the Whitehead are a good place to make the connections, and they were so used lately aboard the Cushing.

On page 429 the probable deflection is given as about 1° per knot of speed of the firing vessel. Later experiments show that 2° is a better estimate for the short Whitehead torpedo and ½° for the Howell. If the Obry gyroscope, now in use abroad and which is being experimented with in this country, realizes expectations, the question of deflection can be eliminated from the mind of the torpedo officer.

The suggestions for simplifying the Whitehead torpedo made on page

431 might be given a trial. It is well, however, to bear in mind that many bright people have been working at the Whitehead for thirty years, and that the first presumption should oppose minor changes. Of course the torpedo is improving all the time, and *some one* must think out the changes. Consequently, all those that seem of sufficient merit should be given a trial.

In regard to the installation of torpedoes, as discussed on page 438, Mr. Ellicott arrives at the almost unanimous conclusions instanced by foreign practice. Let us by all means take up under-water fire. From all accounts it is by far more accurate, and no one can doubt its greater tactical value.

His conclusion as to control of fire—not by the captain, but by responsible persons at observation posts—is also accepted everywhere. Our own sighting arrangements are designed entirely on that principle, except in the case of the bow torpedo, if there is one, which is fired from the conning tower. Probably no more bow or stern torpedoes will be installed. They are even now being removed from ships which had them.

I do not agree with the views of the essayist on page 440 as to the desirability of installing torpedoes aboard cruisers and gunboats. These vessels should be built for one purpose alone, should have a light battery and as much speed as possible, and should not be hampered with extra weights and fittings of no ordinary utility and of possible use only in emergencies little likely to arise. In most cases the fittings would be shot to pieces before there was any chance to launch the torpedoes. Has the essayist considered the ethics of destroying merchant vessels by torpedo fire?

The discussion as to a torpedo-boat depot and drill ground, beginning at page 441, is the very best thing on the subject that I have chanced to see. I cannot think of a requirement that is not noted among those he mentions. And I do not see how there can be any escape from his conclusions as to the general locality to be selected. Surely after this discussion it would seem beyond reason to establish a station at either Boston or Newport. The only possible claim these points can have is that plants now in existence can be utilized to some extent and that they are near centres of labor. At any place selected, even Boston or Newport, sheds and launching ways would have to be constructed, and this would be a large item of the expense. Laborers can be obtained at any point where there are steady employment and fair wages.

In the programme of exercises on page 444 it does not strike me that torpedo-boats should be used to work out general tactical and strategic problems, simply because there will be no time for such work. Torpedo work and torpedo tactics will occupy every particle of time that may be available. For the same reason I do not believe they should be employed in reconnoissance of harbors and interior waterways, except for their own use, which is of course very important. The whole interior waterway system should be thoroughly developed and charted on a scale suitable for torpedo-boat navigation. For the preparation of plans of defense and war charts under the War College, I should think the college could ask

for and obtain two small light-draught vessels designed expressly for such use, which, with larger quarters and deck houses, would be in every way better adapted for the purpose.

THE CONSOLIDATED MESS OF THE CREW OF THE U. S. S. INDIANA.

Lieutenant-Commander E. B. BARRY, U. S. Navy.—I have read with great interest the paper by Lieutenant Decker on the consolidated mess of the Indiana. The idea is a very good one. Everything tending toward consolidation in internal affairs aboard ship is a step in the right direction, provided it does not go too far. I think, however, if the chief petty officers are exempted there is no reason why the first-class petty officers should not be; it would help to maintain the distinction between them and the ship's company, and after all would be only one more mess.

In connection with this subject is that of a beer canteen. I am not a "water drunkard," but I believe in real temperance, and I have yet to see any good results coming from a beer canteen. It is almost impossible to prevent doubling, and many men get loggy with beer, the taste grows, and where one day one bottle was sufficient, next week two will be hardly enough.

I do not ascribe the murder of the Indiana's master-at-arms directly to the canteen, but the probabilities are it would not have happened if there had been no beer about.

I look upon a regularly instituted beer canteen, especially when cargoes of beer are carried about from port to port, as injurious to the *morale* and discipline of a man-of-war.

It is the entering wedge to undo the grand work of the late Flag Officer Foote and others, who saw the evils of the spirit ration and succeeded in abolishing it. I trust most devoutly we never shall return to the condition of affairs existing before 1860.

Whether the mess can be maintained on a foreign station is yet an unanswered question. The difficulties are greater than at home, but I can see no reason why they should not be overcome. If a satisfactory solution is reached abroad, perhaps the consolidated mess may become part of the Department organization.

In my opinion the best man to have charge of the funds would be the ship's paymaster; the commissary yeoman would fall naturally under his direction. I repeat that the idea is a very good one and warrants general trial. If it works under all conditions it should be adopted as the Navy system.

Lieutenant-Commander DANIEL DELEHANTY, U. S. Navy.—I have read with pleasure Lieutenant Decker's paper on the consolidated mess of the crew of the U. S. S. Indiana. The subject is one concerning which I have been deeply interested for many years past. It has long been my opinion that the system in vogue for messing the men in our ships is faulty in the extreme, as bad a one as could be devised for all concerned.

About eleven years ago, while executive officer of the receiving ship Independence, Mare Island Navy Yard, under Captain Frederick Rodgers, I had the honor to put in successful operation the first consolidated mess. Like all innovations, it at first met with considerable opposition, but after a month or two the advantages were so manifest to the men in the better character of the food, its superior preparation, economy, cleanliness and adaptability, that all opposition ceased and the men willingly conceded that it was the only satisfactory way for them to mess on board ship, and the Independence mess is to-day operated exactly as it was ten years ago.

I have always believed and advocated that the system is wholly practicable for sea-going ships as well as for receiving ships, and that the proper way to run them both is on identically the same lines.

Nothing tends more to the contentment and comfort of a ship's company than a satisfactory commissary, and I believe the true way of accomplishing this is by the adoption of the system outlined.

On the first of last June the single mess was formed on board this ship under my personal supervision, with five cooks, the total number of men in the mess being three hundred and forty-five, which includes the entire crew excepting the officers' servants.

A temporary pantry was established on the gun deck abreast the galley. Two of the cooks were assigned to this pantry to prepare the food for the galley and to distribute it afterwards to the mess attendants; three of the cooks were stationed at the galley to attend to the cooking. A commissary yeoman was designed to select and order the supplies, a petty officer and a non-commissioned officer of the Marine Guard were named to advise with the yeoman and to certify to the correctness of the bills.

Under authority of the Navy Department one-half the number of rations were commuted. The practical results at the end of the month were that the men lived considerably better, the character and preparation of the food were greatly improved, and, barring miscalculation of the quantity necessary on several occasions, the men were clearly well satisfied with the experiment. No one had to contribute a cent to the maintenance of the mess, while the contributions from individual messes before that time varied from two to five dollars per month for each man. At the end of June the mess, however, was found to be in debt sixty dollars. For the month of July the number of commuted rations was increased to three-quarters of the whole, and at once a decided improvement in the mess was the result, with a surplus at the end of the month of one hundred and ninety dollars; this, after paying to each of the five cooks ten dollars, which, in my opinion, is an equitable, wise and satisfactory arrangement, as it stimulated the cooks to the best performance of their duties.

On the first of the present month the commanding officer directed the reduction of the commuted rations to one-half until such time as the Department may authorize an increase.

With all my experience in the conduct of this system of messing, I am unqualifiedly of the opinion that all rations should be commuted. It may appear to those who are not fully conversant with all the conditions that this would be a radical and dangerous experiment, but I am clearly of

the opinion that it would be otherwise. No more room would be required than under the present system; very little, if any, more provisions would be brought on board independent of the paymaster; most of the staple articles, such as pork, flour, sugar, beans, tea, etc., will be drawn from the paymaster and paid for at the invoiced prices, all of which would be an advantage to both the crew and the Government.

The system is so well established and so popular on board this ship, and, I believe, also on board the Indiana and Massachusetts, that I am convinced that it is only a matter of a short time when it will be extended to all vessels in the Navy.

There is undoubtedly room for improvements, and with such made, the system will be satisfactory and conducive to the comfort of the crew; the number of desertions will materially decrease, and the men will look upon their ship as in reality their home. I believe I am fully justified in this observation, as the system has been conducted on board under my personal attention and I have carefully noted the results, and the most important one is that since the inauguration of the mess on board, desertions from this ship have decreased more than fifty per cent.

I would strongly advocate—

1. That hereafter the system shall be uniformly conducted on all ships adopting it.

2. That a part of the ship near the galley shall be set apart for a commodious and properly constructed pantry, with a sink, draining overboard, for the washing of cooking and pantry utensils, with an adequate supply of running fresh water; bins of sufficient capacity for the daily supply of flour, sugar, coffee, etc., and that a bread bin be built near the pantry similar to the one used on board this ship, the bottom of which is a movable grating, to accommodate one or more days' supply of bread, with a false bottom below from which to clean the bin when filled.

3. That the practice of permanent seats at the table be absolutely prohibited. This is important, otherwise there is a great tendency for cliques, which exist in all ships, to seize certain tables as their right and to demand, or procure by other means, a discrimination in their favor at the expense of the more tractable men in the crew.

4. That all rations be commuted. If the Navy Department will consent to this it will unquestionably contribute to the success of the mess. In its operation at present a considerable quantity of the drawn ration is wasted, as the men will not eat it, and it is eventually thrown overboard or returned to the paymaster, the value being lost to the men and nothing is gained by the Government.

In conclusion I wish to say that during the latter part of last month this vessel was assigned to the duty of taking on board part of the New York Naval Militia for one week's instruction at sea and in port. Before the men came on board the commander of the division called on me to make arrangements for their subsistence. He stated that the state allowed each man forty-eight cents per diem for this purpose. I told him that they could be subsisted on board in a satisfactory manner for thirty cents per day, but he urged that his men were used to better fare than they were

likely to receive on board ship and he desired to make arrangements for the additional supply of food. I suggested that our commissary be given a trial first, and on this understanding his men came on board, remained a week, received the same fare as the ship's company, did not expend one cent for additional food, and left the ship loud in the praises of the mess.

I am a firm advocate of the system under discussion and believe it will come to all ships to stay, and will bring and keep in the service a superior class of men.

Captain C. M. CHESTER, U. S. Navy.—There is no question but that the crew of a ship, save perhaps the 1st class petty officers, should be in one mess, and that the food should be prepared by two, three or more cooks of a much higher grade than those that heretofore have been found as a part of the complement of our ships of war.

The assistants, under the direction of the head cook, should prepare all food for the ship's company, in the same way, and serve it to the messmen or waiters (erroneously styled berth deck cooks) for distribution to the crew.

I am totally antagonistic to the plan of commuting rations and purchasing food to suit the tastes of individuals, for it would seem to me this matter should be controlled by the highest authority. The paymaster, who is the commissary of the ship, as far as Government supplies are concerned, should take charge of all purchases for the crew, and not have a part of them furnished by him and the rest by a line officer detailed for the purpose.

The messing should "have the personal interest and assistance of the executive officer," as is required by regulations.

The rations should consist of plain, wholesome food as at present provided for issue at sea, and as a change, a suitable variety of fresh provisions in port; these should be strictly defined by regulations, to be made, however, elastic enough to take in the market of the port visited and the season of the year.

The commanding officer of a ship, or when in squadron, the commander-in-chief, should direct the purchase of "harbor rations" as may be required, in the same manner as provided for other Government supplies. When the ship goes to sea, as well as on two or three occasions during the week in port, as preparatory for sea service, the ship's company should be put on sea rations, with such small additions of vegetables as the present regulations contemplate; the whole idea being that the supplies of food, like all other supplies, should be under the direct control of the commanding officer. He then would be prepared, at all times, to move his ship at short notice for any service that may be required of him and for which he may not be able to make any special preparations.

What would become of the Indiana plan if that ship was suddenly ordered to watch an enemy's port, or sent under secret instructions, of which no information could be given to any one?

Why should a coal bunker be used for an issuing room for extra supplies when the ship is already deficient in coal endurance?

Any of us might say, "I never lived better in my life" by taking our meals at Delmonico's or some other famous hostelry, but the question we must consider is, what would be the effect of such living on the physical condition of men who are being educated for the struggle of battle.

If the food the Government provides is not suitable, let us make a change; but let us do it without sacrificing the principles of military control.

Frequently the Newark, during her last cruise, was required to proceed to sea upon telegraphic instructions, which did not permit laying in of supplies, and once she remained at sea for a month without other than sea stores.

Another strong objection to this messing system, to my mind, is its associations with a canteen, "started for the serving of beer, the profits of which went towards bettering the food that could be furnished."

The profits from this unwholesome traffic amounted to $3000 on board the Indiana, but from whom was this large sum drawn? The men themselves furnished it, and it is hardly probable that they would have been willing to have this tax levied upon them save that through it they were enabled to procure more beer; and their demand for an increase has added to the quantity which was at first allowed (one bottle per day), to three and four at the present time.

The fund could easily be doubled by increasing the allowance of beer, or money could be made for the mess by allowing the apprentices to join the beer club, which happily has thus far not become a common practice.

A number of years ago the whiskey ration, owing to popular disapproval, was abolished by an act of Congress; since that time the moral tone of the Navy has greatly improved, and yet recently we have gradually introduced a beer ration that not only contains more alcohol, but which (physicians tell us), taken with the other ingredients of beer, is the most baneful beverage that man can drink, enervating the system and debasing the moral senses.

It is pointed out by those favoring the use of beer in the Navy that drunkenness has decreased since beer was allowed and it is due to this cause; but I claim that this beneficial result is owing to a growth in moral sentiment among the men and is in spite of this handicap.

There are few ships, in my opinion, where grave breaches of discipline cannot be traced to the beer ration, and I wish the messing system, whatever it be, could have this prop taken from under it.

Lieutenant W. F. Fullam, U. S. Navy.—It is fortunate that the Navy Department and the Naval Institute are alive to the necessity for an improvement in the system of messing the enlisted force on board ship. The present indications are that a plan will be devised which will give satisfaction to the men and greatly improve the efficiency of the ship.

In this connection it may not be amiss to consider the following statements and suggestions which have been made in a most respectful and subordinate manner by an intelligent petty officer serving afloat:

"On board this ship we have twenty messes and it takes twenty cooks and eight assistant cooks to run them. A sum of $400 is paid monthly by the messes to these men for cooking.

"Of course every officer in the service knows that much the same state of things exists on board other cruising ships. They are aware of the waste of money in paying cooks, the exorbitant prices charged by bumboats, the frequent occurrence of runaway caterers leaving their messers hungry for a month or two, and how hard it is for a 3rd class apprentice to contribute monthly to his mess.

"Under the present system the bumboat is a great source of expense to the men. The following table will show the difference in prices charged for certain articles ashore and by the bumboat in the port:

	Bumboat.	Groceryman ashore.
Potatoes, per 100 lbs.	$1.60	$0.85
Eggs (100)	1.32	.88
Milk per quart	.10	.05
Milk, condensed	.20	.15
Scrubbing brushes	.35	.25
Tooth brushes	.25	.15

"The men could be saved a great deal of expense from bumboats if certain articles such as writing paper, ink, toilet soap, towels, etc., could be purchased on shore and a small space allotted to them on board ship (a U. S. Army canteen on a small scale). Reasonable prices could be charged for these articles and the profits turned in for the benefit of the general mess.

"Men who have lived under Lieutenant Delehanty's messing system, which was applied with such success on board the Independence in 1889, believe that a similar system with certain modifications could be adopted on board cruising ships. By having a proper allowance of ship's cooks the men could be put in one mess with a competent caterer at its head. With one-half the rations commuted and by the adoption of a small canteen on board each ship, the profits of which should go to the mess, the men could live well without being obliged to contribute a monthly sum of money."

These statements merit attention.

The existence of a large surplus in the case of a general mess has caused some dissatisfaction. But this difficulty can be easily removed. If the mess accounts are squared monthly, a man who is detached from the ship may be paid his proportional share of the surplus, and a new man entering may have the same charged against him, just as in the case of officers' messes.

Captain A. S. Barker, U. S. Navy.—I have read Lieutenant's Decker's article on "The Consolidated Mess of the Crew of the Indiana" with interest. Whether or not the system will prove as efficient as the present method of messing, under all service conditions, can be determined by further trial.

I do not understand that the "canteen" is necessarily a part of the system; if it be, I am opposed to it.

I neither believe in having canteens on board our men-of-war, nor in having beer brought alongside in boats to be peddled to the crew.

It is time drunkards were weeded out of the service, and in my opinion no custom should be tolerated which tends to promote or keep alive a taste for drink.

I know there is, or has been, a difference of opinion on this subject, but I think that many of the former advocates of the innovation are now convinced that its influence is pernicious.

For one, I wish the Navy Department could see its way clear to forbid the custom. It has never obtained on the U. S. S. Oregon.

CONTINUED DISCUSSION OF ESSAY BY DOHRMAN. (See No. 82.)

JOHN S. WATTERS, Comdr., La. N. M.—The paper of Mr. H. G. Dohrman contains so much that is valuable that it is hard to cover all the points in a brief discussion. That the facilities for educating officers who have had no nautical experience, so that they may be even theoretically posted on a small fraction of what an officer of the Navy is expected to know, are at present so meagre that but little progress can be made, probably every commanding officer who has himself served in the Navy will admit without argument. That it is impossible for officers at a distance from Newport to attend the War College or Torpedo School is another thing that admits of no argument. The officers of the Naval Militia are mostly men whose time is not their own and whose means are limited. What attention they can give to their militia organization is only during the evening and on Sunday, and it can scarcely be expected of the most enthusiastic man in the world that he shall give every evening and every Sunday; but it would take pretty nearly that to enable him to obtain a fair grasp of his duties. As for the commanding officer, so many minor details must necessarily receive his attention that it is impossible for him to give proper attention to the instruction of officers.

I agree thoroughly with Mr. Dohrman's plan of a detail of naval officers who would come prepared to deliver a systematic course of lectures, following a well considered plan, for the instruction of the officers of the Naval Militia. A few lectures would do more good than any amount of literature, which would not make anything like the same lasting impression. Further, no greater encouragement could be devised than the manifestation of such an active interest in the Naval Militia by the Department. A certain amount of preliminary literature of such a character as could safely be disseminated would enhance the value of the course of lectures.

Provision should be made by Congress for defraying the expenses of commanding officers, so that they can attend the War College and Torpedo School. The actual expenses of transportation and the pay of their

grade while on such duty should be allowed them. This should be paid out of the national treasury, as the Naval Militia organization is, to a certain extent, national in its character, and the instruction of the commanding officers is a matter of sufficient importance to warrant this trifling outlay. Those who could spare the time could thus avail themselves of the opportunity, which is now a matter of impossibility for most of them; while if the various State legislatures had to make such provision, it would be a long time before it could be accomplished, if accomplished at all. This may strike some persons as savoring of mercenary motives, but as long as commanding officers are not millionaires, as they undoubtedly should be, there is no other way for them to get the instruction which it is important they should have. It would be little enough recompense for their outlay of time, trouble and money in a worthy cause.

I offer this as a suggestion, as there is a great deal that could not be touched upon by the officers detailed as lecturers to the officers generally, and of a character which could not be printed, but which commanding officers should know.

The listing of all merchant steamers visiting the port during the year, and keeping up with the condition of her machinery, coaling facilities, supplies generally, machine-shop facilities, etc., of local towns, is legitimately within the province of the Naval Militia, as is also the reconnaissance work which has been so successfully carried out by the New York battalion; the only difficulty in the way being that, as nights and Sundays are the only time during the year available for devotion to such work, barring perhaps a week during the summer, progress will naturally be slow in this direction.

PROFESSIONAL NOTES.

THE PROTECTION OF WARSHIPS.

Writing in *Le Yacht*, M. E. Duboc deals with the use of cellulose on warships as a means of preventing the entrance of water through a shot-hole. When the matter was first investigated, very satisfactory results were obtained. The cellulose being compressed into cofferdams behind the plating, was found to swell after the passage of a shot, and completely close the opening to water. Many French ships were accordingly protected in this manner, but further experience then showed that the cellulose under the conditions named was liable to decomposition, when it lost its obdurating properties; and further, when set on fire it burned with a most pungent smoke. Owing to these drawbacks, the use of cellulose in this way was abandoned on French vessels, being removed where it had already been fixed. The battle of Yalu, however, has shown that, if the disadvantages named can be overcome, the method has much to recommend it. Thus if the Chinese and the Japanese boats are compared, it will be found that the latter, which were protected with cellulose, came through the ordeal of perforation by shell fire the more satisfactorily. Thus the Chinese boat Tshi Yuen, struck near the water-line by a large shell which let in the water below the armored deck, capsized and went to the bottom. A similar fate awaited the armored cruiser King Yuen. On the other hand, the Japanese Itsukushima was struck by a 6-inch shell a little below the water-line. The projectile passed through two bunkers and burst in the aft stokehold. Some fragments of the cellulose packing traversed were carried with it by the shell and burnt, but the coal did not take fire. The sea entering the breach caused the cellulose to swell and to almost completely stop further entrance of the water. Similarly on the Matsushima two shot-holes amidships were equally stopped up by the automatic plugging action of the cellulose. In view of these facts M. Duboc raises the question as to whether the French Admiralty did not act somewhat too hastily in their precipitate abandonment of the use of the material in question, the more especially as further experiments in the United States have led to its extensive adoption by naval authorities of that country. As regards another matter, M. Duboc states that the Japanese have made some remarkable experiments in connection with the best means of strengthening a hull against torpedo attack. Two hulls were prepared, each with an inner shell, the space between the two being in one case left empty, and in the other packed with bamboo. On exploding equal charges against the outer shell of each, the first-named hull had both outer and inner skins wrecked, whilst in the second case the inner skin escaped injury almost completely, though the bamboo packing was reduced to shreds.—*Engineering.*

NEW TORPEDO TUBE FOR JAPANESE BATTLE-SHIP FUJI.

The following is from the London *Times:*

After leaving Spithead, where she represented the Japanese navy during the review, the battle-ship Fuji proceeded to Portland in order to carry out her torpedo and gunnery trials. On Thursday, July 15, she left the roads and occupied the whole afternoon in running torpedoes from her new submerged tubes. Runs were made at various speeds up to rather over 16 knots. The success of these trials is an important matter, and the Fuji and her sister ship the Yashima are the only two foreign ships which for the present possess submerged torpedo tubes.

The late war between Japan and China taught the belligerents and the world at large the risk a ship ran in carrying torpedoes for above-water discharge, exposed as they must be (if kept ready) to the fire of the enemy. If either the air chamber or the gun-cotton charge be hit, an explosion which may well cripple or destroy the ship must occur. The Japanese Government, guided by this experience, determined if possible that their future battle-ships and large cruisers should be fitted for the submerged discharge. They therefore applied to Sir W. G. Armstrong, Whitworth & Co., Limited, for designs of an apparatus. This was got out, and the firm undertook to carry out experiments with models in order to study the question thoroughly. The Japanese Government were bold enough to order the submerged tubes without any experiments with real torpedoes to prove results, and it must be most satisfactory to them to find they possess submerged tubes which are in every way satisfactory and in many ways surpass the performances of the English tubes.

The Elswick tube is in nearly every feature a completely new departure. The ejection is preferably made by means of cordite, although compressed air or steam may be used. Cordite is simple to handle and possesses the great advantage over the other two systems of being always ready for use. Its introduction for firing torpedoes as well as guns must be considered as an improvement.

Another marked feature in the Elswick tube is the automatic return. With it it is possible to withdraw the men and close up the submerged torpedo room, after having prepared the tube for firing, as no further attention is required. Hours afterward it will only be necessary to press the firing key, when the guide or shield will instantly be forced out, the torpedo discharged and the shield returned, the three operations following each other in such quick succession that they only occupy a total period of about a second. This rapid ejection and return seem to get over the difficulty of vibration hitherto experienced with submerged tubes. The shield has not time to set up vibrations. Again, the rapid return helps to clear the tail of the torpedo from the shelter of the shield, and this probably accounts in some measure for the small deflection with which the torpedo is ejected.

The velocity of discharge of the torpedo from the Elswick tube when the ship is at rest is 50 feet per second. At a ship's speed of 16 knots the velocity is probably about 45 feet per second. These velocities are much higher than are used in the English system, and yet the maximum pressure on the torpedo does not exceed 30 pounds per square inch.

One torpedo only was used throughout the trials on board the Fuji. It was picked up each time, recharged and ejected again; yet at the end

of the day it did not show a mark or sign of ill-usage or strain. The tube was so easily worked that it was always ready to receive the torpedo long before it could be secured and recharged. On account of the small deflection the practice at a boat was excellent. The torpedo used was an 18-inch long torpedo made at Fiume.—*Iron Age.*

CYLINDRICAL WATER-TIGHT DOOR.

Mr. Kircaldy, of Glasgow, has invented and patented a new type of water-tight door which bids fair to eclipse, with respect to general utility and efficiency, many existing water-tight doors. To the bulkhead, where the door is to be fitted, is bolted a hollow cylindrical casing, with two doorways in its circumference; within this casing revolves a hollow cylinder with a doorway in its circumference. To pass from one compartment to another, when the ingress doorway is in a line with the bulkhead doorway, the passenger enters and stands on the bottom of the casing and revolves the hollow cylinder by hand until he brings the ingress doorway into line with the second bulkhead doorway, which permits of egress from the casing. The remarkable feature of this "double door" is that it is absolutely impossible to leave it open, as one door must be effectively closed before the other opens, thus complying with the recommendation of the Board of Trade's Bulkhead Committee of 1890. The revolving cylinder is hung on ball bearings, and it is easily brought into the position desired for ingress or egress. At the same time no gear, so familiar to other types of water-tight doors, is required; consequently no attention on the part of the ship's crew is demanded.—*United Service Gazette.*

TRIAL OF SIMS-DUDLEY GUN.

A trial has been made at the artillery range of Sir W. Armstrong, Whitworth & Co., Silloth, on Friday, of the Sims-Dudley powder pneumatic gun, which is said to be the only gun in existence by which high explosives can be fired by the use of gunpowder. This weapon, which was manufactured by the Sims-Dudley Defence Company, of New York, is of 2½-in. bore and weighs 270 lbs., or with carriage, 500 lbs. Its length is 10 ft., and from the muzzle to the end of the carriage 12 ft. Air pressure reaching to 6000 lbs. to the square inch being produced by the explosion, no air-compressing plant is needed, and the gun is a self-contained, complete weapon. It consists of three tubes, arranged side by side on the same horizontal plane, the middle and longest tube being the main barrel from which the projectile is sent upon its journey. The other tubes are connected with each other and with the main tube. It is worked by two men, and the method of loading and firing being simple, six rounds may be fired per minute. The cylindrical projectile is of the same type as that used with a dynamite gun, and when charged weighs 11 lbs. In the main body of the projectile is placed a 4-lb. charge of explosive gelatine; in the front end a 6-oz. charge of dry gun-cotton, and in the gun-cotton is a cylindrical case containing 30 grains of fulminating mercury. The ignition is effected by a mechanical fuse, and when the shell strikes the water or any other object, a steel ball within it is driven forward, owing to the sudden retardation, and, striking one or more per-

cussion caps, causes a detonation, which ignites a tube of slow-burning powder, and this communicates with the fulminating mercury and so explodes successively the gun-cotton and the main explosive in the shell. The trial, on July 9th, was conducted in the presence of Lieutenant Moe, representing the Norwegian Government (for whose benefit it had been arranged), and Mr. Smithson, from Sir W. G. Armstrong, Whitworth & Co., and the spectators were much struck with the capabilities of the weapon. The longest range at which the projectiles were thrown was about 1750 yards. The explosions were very great when the projectiles fell, and it was afterwards ascertained that they had made holes 6 ft. to 8 ft. in diameter and 4 feet deep in the soft, wet sand. The gun will be taken to France to be tried by the French Government, and afterwards, at the request of the Sultan of Turkey, it will be tested in the Dardanelles.—*Engineer.*

ENGLAND'S FLEET MANŒUVRES.

War between the two divisions of the Channel Squadron, stationed respectively the first at Lough Swilly and the second at Blacksod Bay, will be declared at midnight on the 7th of July. The area of operations is bounded by the arc of a circle drawn from Blacksod Bay with a radius of 350 miles extending from the point where this circle cuts the 52nd parallel of latitude to the point where it cuts the 7th meridian of longitude. From these points to the nearest land the parallel and meridian named become the boundaries of the area. Late in the afternoon of the 7th the Second Division will put to sea, leaving one cruiser behind to bring on the news that war has been declared. This cruiser will leave Blacksod Bay at midnight and steam direct to a rendezvous prearranged with the battle-ship squadron of the Second Division. The position of this rendezvous is unknown to the other side, but cruisers of the First Division, presumably the Powerful and the Terrible, will be allowed to leave Lough Swilly in the course of the 7th and to take up positions north and south of Blacksod Bay by the time that war has been declared. These cruisers are not to attempt to follow the Second Division on its exit from Blacksod Bay, nor the cruiser which leaves later, but they are to wait near the coast until a specified time after war has been declared. At an early hour on the 8th inst. they are to proceed at a speed of 17 knots to search for the hostile cruiser, assuming that she has steered to the westward of them in a constant but unknown direction at a uniform speed of 12 knots. If either of them sights her she is to endeavor to escape, and for this purpose she will apparently be allowed to use her utmost speed, and if it should seem expedient to change her course if she is overtaken, she is required to inform her pursuers of the rendezvous for which she is making, and if she is put out of action under the rules she must return to Blacksod Bay and take no further part in the operations. In the meanwhile, the admiral in command of the First Division is empowered to send his remaining cruisers out to scout as soon as war is declared, but may not quit Lough Swilly with his battleships until the next day. The admiral of the Second Division will wait with his battle-ships within fifteen miles of his rendezvous until his cruiser has reached him, or, if she has failed to reach him, from daylight on the 9th instant until daylight on the 10th; but if during that period he is warned by his cruisers of the near presence of his adversary's battle-

ships he may endeavor to evade their pursuit. Subject to these conditions his object is to evade his adversary and to return to Blacksod Bay, the corresponding object of the First Division being to discover the whereabouts of the Second Division and to prevent its return to Blacksod Bay, and this object being adjudged to be accomplished if the battleships of the First Division have at any time got within three miles of those of the Second Division before the latter have reached a point ten miles from the entrance to their port. The operations will in any case be brought to an end at six o'clock in the afternoon of the 11th, ninety hours after the declaration of war.

It will be seen at once that the main stress and interest of the operations will center on the proceedings of the two cruisers told off to search for and intercept the hostile cruiser which is to leave Blacksod Bay at midnight on the 7th and to carry the news of the declaration of war to its own fleet at a rendezvous unknown to its adversary. If both these cruisers fail to accomplish their purpose, the task assigned to Admiral Stephenson will be reduced to that of looking for a needle in a bottle of hay, but their prospects of success are not inconsiderable under ordinary conditions of weather. The problem to be solved by them is as follows: A ship, *A*, leaves a certain point at an hour which is known and steams at a speed which is known and constant, but in a direction which is unknown save that it lies somewhere in an arc of 180°, of which the center is the point of departure. At each successive hour after her start *A* will be found on some point of an arc of which the center is her point of departure, and the radius the number of miles she has traversed at her known hourly speed, in this case 12 knots. Some hours after she has started, two other cruisers, *B* and *C*, each having a speed of 17 knots, start in pursuit from two points on the diameter of the arc equidistant from its center. From the geometry of the case it is manifest that their courses will be symmetrical, and, therefore, only one of them need be considered in detail. Obviously, if *A* pursues a course which brings her within sight of *B* before the latter starts, *A* will be intercepted within a few hours of her departure, but if she pursues a course slightly more divergent, *B*, when she starts, must shape her course so that it intercepts that hypothetically assigned to *A* at a point to which their known speeds will have brought them simultaneously. If the course hypothetically assigned to *A* should turn out to be the one actually pursued by her, the two ships will meet at this point, and in any case it is certain that when *B* is at this point *A* is somewhere on the arc of the circle hypothetically, and so far as *B* is concerned, on the quadrant, of which the center is *A's* point of departure and the radius a line joining the point reached by *B* to the center. Thenceforward the hourly distance covered by *A* and *B* will be twelve and seventeen miles respectively, and if at each successive hour *B* alters course so as to cut through the arc on some point of which she must be found, she will, when she has traversed the whole quadrant, have steered throughout a series of points, some of which *A* must have traversed simultaneously if her course lay in the quadrant at all. Precisely similar reasoning applies to the course of *C*, who will traverse an exactly similar curve in the other quadrant of the semicircle in which the course of *A* must necessarily be, so that, geometrically speaking, it would seem to be certain that *A* must be intercepted by either *B* or *C* at one point or another in the two courses traversed by them which lie symmetrically disposed in relation to the line which divides their respective quadrants.

The course thus indicated as that to be pursued by *B* and *C* respectively is called the "curve of search," and its geometry is explained in a paper issued with the instructions relative to the manœuvres. The curve of search is a device elaborated by two French naval officers, and the system on which it is based is very fully expounded in a volume entitled "Essai de Strategie Navale," published a few years ago. Geometrically it is unimpeachable, but its success in practice must manifestly depend not only on very favorable conditions of weather and navigation, but on an accurate knowledge of the speed and course of the pursued, and an equally accurate adapting to it of the speed and course of the pursuer, conditions not very often likely to be combined with adequate precision in the varying circumstances of actual warfare. However, as the art of scouting with modern warships is still almost in its infancy, it is perhaps worth while to try an experiment based on this geometrical method. If it fails to solve the problem propounded in the forthcoming manœuvres, its practical value for the real purposes of war will be largely discounted, because it is very unlikely that in real war the speed of a hostile cruiser would be accurately known to its opponents, or that such a cruiser would neglect the very obvious evasive expedient of frequently altering her course as well as her speed, and because the whole success of the method depends on the accurate appreciation and adjustment of the geometrical conditions involved.

The rules and regulations to be observed by the two opposing divisions of the Reserve Squadron during the manœuvres are as follows: The duration of "active operations" will extend from midnight of the 7th to 6 P. M. on the 11th instant. No hostile act may take place except during those 90 hours. Vessels at sea before the 8th are merely out in preparation. Battle squadrons cannot be divided, and must be intact at the moment of carrying out their object. The action assigned to cruisers is primarily, on the one side, to screen their battle squadron from observation, and, on the other side, to get touch with the opposing battle squadron in spite of its cruisers, and communicate with their own admiral. Cruisers can be put out of action according to the following rules: A first-class cruiser can put out of action a second-class cruiser if she can remain within a mile of her for 50 minutes, or a third-class cruiser if within a mile of the last-named for 30 minutes. Similarly, a second-class cruiser can put a third-class cruiser out of action if within a mile of her for 40 minutes. Two second-class cruisers can put a first-class cruiser out of action if they both remain within a mile of her for 100 minutes, and two third-class cruisers can put a second-class cruiser out of action if they are within a mile of her for 80 minutes. Some other combinations may be used, as for example, one first-class with one second or third-class cruiser can put a first-class cruiser out of action by remaining within a mile of her for 70 minutes, or one second and one third-class can disable one of the second-class by being within a mile of her for 40 minutes.

Provided, however, a larger group than two meet a group on the other side, it must be divided in order to act in accordance with the above rules. The period of action is to be between the two guns which the larger ship must fire to mark it. The first is to be fired when the two ships, in the judgment of the officer observing from the larger ship, are within the prescribed distance, and the second at the expiration of the time allowed. No other guns than those are to be fired. Cruisers put out of action under these rules can take no further part in the

manœuvres, but must return to their port flying the pilot-jack at the fore. They may select their own route, but they are strictly enjoined not to communicate any information as to the progress of the manœuvres to the ships of either side whom they may meet on their way. At the expiration of active operations, cruisers at the ports will carry out such orders as they have received relative to target practice and to their return to the ports of inspection. A copy of the ship's log and signal log of any ship taking part in the manœuvres, commencing 12 hours before and ending 12 hours after active operations, is to be sent to the Admiralty with the reports of the admirals in chief command. A board of umpires is to be formed in each fleet from the captains of battle-ships to decide upon the claims made by the cruisers of each division.—*Journal Royal United Service Institution.*

TESTS OF ARMOR AND SHELL.

[United States.]

A most successful test was made at the Bethlehem Iron Company's testing grounds, at Redington, of a plate representing 650 tons of side armor for the battle-ship Kentucky, now being built at Newport News. Two shots were fired at the plate. The first was a Carpenter projectile weighing 500 pounds. A charge of 138 pounds of powder was used, generating a velocity of 1479 feet per second. The penetration was between 7 and 8 inches. No cracks were developed. The second shot was a Holtzer projectile of the same weight as the first, 500 pounds. A charge of 3230 pounds of powder sent it against the plate at a velocity of 1600 feet per second. The penetration could not be determined because the projectile was welded to the plate at the point of impact. No cracks were developed. This armor and also that for the Kearsarge were contracted for before the present agitation about the price of armor plate.

Turrets of New Design.

Steel turrets of new design have been adopted by the Navy Department for use on the battle-ships Alabama, Wisconsin, and Illinois. They are the design of Assistant Naval Constructor Dashiell and are unlike those carried on any other warship. In the new turrets 13-inch guns will be installed, capable of a most destructive fire, and at the same time well protected from bombardment. The main features of the new turrets are vertical walls on the rear and sides and a sloping plate in front. The plates are of a uniform thickness of 14 inches, the front plates sloping 42 degrees to the horizontal. At such an inclination it will be almost impossible for any projectile to penetrate the plate, while the vertical plates would resist a 12-inch shot at 2000 yards' range. One of the chief advantages of the inclined plate is its deflecting qualities. It has been recognized that the necessity for keeping the turret guns trained at all times on the enemy opens the immediate front or exposed part of the turret to serious consequences, while, with a curved plate that will deflect the projectiles, it will be almost impossible to do the turret any great harm when the deflective parts are presented as the target.

Change in Armor Tests.

Instead of firing at plates with ordinary armor-piercing projectiles, the new requirements permit the Department to use capped armor-piercing

projectiles if it be thought desirable. In addition the cracking shot is done away with, and the two shots, which the specifications require to be fired, are given the same velocity. Comdr. O'Neil, Chief of the Ordnance Bureau, holds that the cracking shot has never been of service. The velocity usually given a shell fired for testing the resistance of the plates with reference to cracks was very low, for an 8-inch plate, for instance, fired at by an 8-inch gun, being 1290 feet per second. What is commonly known as the perforation shot when an 8-inch plate was undergoing test and an 8-inch gun being used, was given a velocity of 1558 feet per second. The only result of the difference in velocities was to make the tests of the plate less severe than they should be. In the test of an 8-inch plate by an 8-inch gun, it is proposed under the new specifications to discharge two capped projectiles at the target with a velocity of 1404 feet per second, and when uncapped projectiles are used, to fire them with a velocity of 1564 feet per second. The new specifications require the use of a 4-inch gun in testing armor of 3 and 4 inches in thickness; a 5-inch gun for armor of 4, 5, 6 and 7 inches in thickness; a 6-inch gun for armor 5, 6, 7, 8 and 9 inches in thickness; an 8-inch gun for armor 8, 9, 10, 11 and 12 inches in thickness; a 10-inch gun for armor 10, 11, 12, 13, 14, 15 and 16 inches in thickness; a 12-inch gun for armor 13, 14, 15, 16, 17 and 18 inches in thickness, and 13-inch gun for armor 15, 16, 17 and 18 inches in thickness. When armor of the same thickness is liable to test by two guns, the Department may choose either caliber.

[ENGLAND.]

TEST OF VICKERS PLATE.

Messrs. Vickers, Sons & Co. (Limited) had a most successful trial of a 4-inch special nickel-steel armor plate on board the Nettle on July 20 under the direction of naval officers at Portsmouth. The plate was 4 ft. square, 4 in. thick, and had no wood backing behind. It was attacked by a 5-in. gun, Palliser projectiles. The first shot was fired with a velocity of 1406 ft. per second, but the plate showed no sign of having been hit. The 50-lb. projectile simply splashed on the face. The second shot was fired with a velocity of 1750 ft. per second, the plate being indented about three-quarters of an inch, but the face was not in any way broken. The third shot also had a velocity of 1750 ft., but the indentation was only half an inch. There were no cracks of any kind in the plate, but the projectiles were in every case broken to fine pieces. Great satisfaction was expressed with this result, as the plate will prove invaluable where thin, unbacked armor is desired.—*United Service Gazette.*

TEST OF BROWN PLATES.

Recently there has been considerable activity at the works of our armor plate constructors, with the view of improving the hardening process and the resistance of the plates, and quite a series of trials have been made on board the old Nettle at Portsmouth. Both plates were tested in the presence of Sir W. H. White, assistant controller and director of naval construction, and of the captain of the Excellent; the principal object of the trial was to determine: "(1) Whether the surface cracks that are liable to occur in manufacture in the case of the most modern plates are prejudicial to their resistance; (2) Whether a plate that has

Official Data of Messrs. J. Brown and Co.'s Armor-Plate Tried on July 20, 1897.

Description.				Point of Striking.	Effect on Front of Plate.	Result on Back of Plate.	Effect of Striking on Projectile.
Round.	Gun used.	Charge.	Projectile, if a Shell, Weight of Burster.				
1*	6-in. B. L.	E. X. E. 48 lb.	Holtzer A. P. 100 lb.	2 ft. from right edge, 2 ft. from bottom.	Size of injury, 13 in. by 10 in.; depth of injury, 2 in.; back of plate set back.	Size of bulge, 14 in. by 14 in.; height, 1¾ in.; semicircular crack on centre of bulge, and horizontal crack on top of bulge. Backing.—Size of indent, 14 in. by 14 in.; depth, 1½ in.	Broken up, point embedded in plate; point of core ¾ in. in front of face of plate.
2†	"	"	"	2 ft. from left edge, 2 ft. from bottom.	Size of injury, 15 in. by 14 in.; back of plate set back locally; surface scaling around round 1; hair line from round 1 to round 2; point of projectile of round 1 jarred out.	Size of bulge, 13 in. by 13 in.; height, 1 in. Backing.—Size of indent, 13 in. by 13 in.; depth, ⅞ in.	Broken up, point embedded in plate; point of core 1 in. in front of face of plate.
3†	"	"	"	2 ft. from left edge, 2 ft. from top.	Size of injury, 15 in. by 13 in.; size of hole, 7 in. by 7 in.; edges of hole smeared; crack showing from round 2 to left edge of plate.	Size of bulge, 9 in by 12 in.; height, 5½ in. Backing.—Size of indent, 9 in. by 12 in.; depth, 5½ in.	Broken up, remains of projectile remaining in the hole.
4†	"	"	"	2 ft. from right edge, 2 ft. from top.	Size of injury, 10 in. by 12 in.; back of plate slightly set back; hair line from round 3 to top of plate; hair line from rounds 1 and 2 developed; point of projectile of round 2 loosened.	Size of bulge, 10 in. by 10 in.; height, ⅞ in. Backing.—Size of indent, 10 in. by 10 in.; depth, ¾ in.	Broken up, point embedded in plate; point of core 1¾ in. in front of face of plate.
5†	"	"	"	Delivered at a point where hair line was showing at centre of plate.	Size of injury 14 in. by 12 in.; surface cracks between rounds 1 and 5, and rounds 3 and 4; hair line from round 3 to top of plate developed; cracking to the right of and below round 1; vertical crack 15 in. long and 10 in. to the right of round 5; point of projectile of round 2 jarred out.	Size of bulge, 12 in. by 12 in.; height, 1 in. Backing.—Size of indent, 11 in. by 11 in.; depth, ⅞ in.	Broken up, point embedded in plate; point of core 1¾ in. from face of plate.

Remarks.—* M. V. 1960 foot-seconds. † M. E. 2663 foot-tons.

been machined to a smooth surface before supercarburization offers a better defense than one that has been carburized on the rugged surface as left from the rolls; and (3) whether a sort of fold, technically called a 'lap,' in the face of a plate causes a local or general weakness." It may at once be said that the results appear to show that the surface cracks did not affect the resistance at all, even when the shot struck actually on them. That the advantage of the tedious and expensive process of machining all over the surface might be considered as affecting alone the appearance and economy in paint—both points to which some importance is attached—and that a "lap" in the face may be a source of weakness if a shot strikes exactly on it, but does not affect resistance under any other conditions, nor does it conduce to cracking.

Both the plates tried—the latter on August 10—were 8 ft. by 6 in. thick, and were cut from a single larger one, which, after rolling, had been straightened and machined on one side to an even thickness of 6 in. The plate tested first—on July 20—had been supercarburized on the smooth side, and the other on the side that had not been machined. The subsequent treatment of the two plates was alike, and as the material was of a new and special kind, the manufacturers were not satisfied with making the plates flat in the first instance, as is usual with test plates, but made them originally concave, and then heated and bent them till they were slightly convex. This was done so that the plates might undergo all the processes that would be necessary if they were to form part of a ship's armor, every plate of which usually requires to be bent, and some very considerably, with the hard side in tension. In the case of the first (the smooth-faced) plate this bending produced some superficial cracks in the face, but in the other it did not. The second plate, however, had a seam where the steel had lapped over itself slightly in forging.

The most recent Admiralty requirements are that a plate of the dimensions given shall resist five Holtzer steel projectiles of 6 in. in diameter and 100 lb. weight at 1960 foot-seconds striking velocity, without serious cracking, and it will be seen that these conditions were satisfied in both instances.

The first of the plates was tested on July 20. All the shot were completely destroyed, and the penetration obtained was slight (about 2 in.) except in the case of the one that struck in the upper left-hand corner, which at first was thought to have just got its fragments into the backing. When the plate was taken down, however, this was found not to be the case. The disc of the plate immediately opposed to the shot had yielded to some extent as if it had been a door hinged on the left side which the blow had partly forced open, but not enough to expose the backing, or let any part of the shot pass through. The other impacts had merely raised slight bulges on the back of the plate, which was practically free from cracks. Some unimportant superficial cracks in the hard face were developed as the trial progressed, and one of these, from impact No. 2 to the left edge, appeared from the front to have gone through the thickness of the plate at that edge, but was traceable only about 2 in. deep when the plate was taken down. One of the superficial face cracks previously alluded to as produced in this plate at the bending stage of manufacture occupied a position in the center, and the fifth round was carefully aimed to strike exactly on it. It did not appear to influence the result in the least, nor did it, or any of the other original surface cracks, show any signs of extension during the trial. The official details of the trial are given in the above table.

The second plate, which presented its rough side to the attack, was tested on August 10. It displayed a "lap" running horizontally across its width through the usual positions of impacts 1 and 2 (but in this case of impacts 1 and 3). The first round was made to strike exactly on it, and the fact that this shot alone out of six got its fragments just into the backing, seemed to show that the plate along the actual line of the "lap" was weakened by it. The second round was fired at the center, and made, in common with all the other rounds, only a shallow indent. To determine whether the weakness caused by the "lap" extended beyond its immediate situation, the third round was aimed just to avoid it by about an inch, and from the result it was evident that the weakness was absolutely local, and that the "lap" had no tendency to produce cracking whether the blow was actually on it or very nearly so. Indeed, the face of the plate after the six rounds showed no cracking whatever beyond a few superficial hair lines, and it is to be expected that when its back is seen, it will show five slight bulges, one hole (where the "lap" was struck) and no cracks. The information derived from these two trials on the experimental points referred to is of considerable value, and the general result was very satisfactory.—*Engineering.*

Recent Armor Trials.

The hope recently expressed that we might shortly obtain results with armor plates which would show that the high standard achieved during the past year can be reckoned on for the future has been fulfilled more quickly than we could have expected. A fortnight ago an excellent result was obtained at Portsmouth by 6 in. plates submitted by Messrs. Brown, the plate being tested on supply, and in the *Times* of August 20 is a report on a much thicker plate made by Messrs. Vickers, tested at Shoeburyness on August 19. The dimensions of this plate were 10 ft. by 7 ft. by 11$\frac{1}{8}$ in. It was backed by 12 in. of oak, and it was attacked by three 12 in. steel Holtzer projectiles, each weighing 714 lbs. It was intended to fire two rounds with a striking velocity of 1850 foot-seconds and the third with 1800 foot-seconds; the stipulation was that no piece of plate or shot should be driven completely through the wood. The first shot, however, was actually fired with a striking velocity of 1861 foot-seconds, and broke in pieces on the plate with a penetration of only 2$\frac{5}{8}$ in., no cracks being formed. Round 2 struck with 1868 foot-seconds, breaking to pieces with 2$\frac{3}{4}$ in. penetration and no cracking. It was then decided to fire the third round with 1860 foot-seconds striking velocity; this only obtained 2$\frac{1}{2}$ in. penetration, breaking up as before without cracking the plate. Thus it may be seen that the resisting power of the plate far exceeded what was stipulated for it. The perforation of the second round, theoretically by Tresidder's formula, was 23.6 in. of iron, which, divided by the actual thickness of the plate, gives 2.02 as the figure of merit of the plate, which is very excellent indeed. The energy per ton of plate of this blow was probably about 1157 foot-tons, supposing the plate to weigh nearly 15 tons.

This, then, is the very result we have been hoping to see in this country; that is to say, it is a magnificent result obtained with a thick plate. It may be urged that it has not broken the record, because Krupp's 11.8 in. plate still stands first with a figure of merit of 2.19, and a shock per ton of 1479 foot-tons. At the same time it is to be observed that it

cannot be proved that Krupp's plate was better than this, so far as we have data. It was certainly subjected to a test which was more severe, but as the Vickers plate entirely defeated the attack, it is probable that it would also have defeated the same attack as that to which the Krupp plate was subjected.

It is foolish, no doubt, to hazard an opinion on a plate which we have not seen, but we would point out that there is evidence that the resisting powers of the plate had evidently so far impressed the authorities that they acted with a confidence which, had it not been justified by results, would have embarrassed them. The first round was delivered with 10 foot-seconds higher velocity than was stipulated; yet the second round had a further excess of 8 foot-seconds, so that apparently no reduction in the charge was made; and the third round was delivered probably with the same charge with a striking velocity of 1860 foot-seconds, or 60 foot-seconds higher than was stipulated. It would have been awkward had this driven any metal completely through. So that it is clear that the behavior of the plate had put such a contingency out of the question in the judgment of those experts who witnessed the trial both on behalf of the Government and of the makers. It reads also as if the Vickers plate was one taken to govern supply pending the erection of proof butts on Whale Island; and if so, we must accord it credit on this account. In fact, it would be better to separate supply and champion plates, and accord this the credit of being the record "supply thick plate," while Krupp's is the record "champion thick plate." It may be observed that we are writing without the full information and data which we hope may be forthcoming by-and-bye, because we regard the trial as one of such importance as to deserve the facts which we have to be made known without delay. We should think that the figures given bear the stamp of accuracy, although we imagine that an important mistake has been made in calling the plate a nickel Harveyed plate. Messrs. Vickers have adopted the Krupp process, and have specially dwelt on its excellence for thick plates; it is extremely unlikely then that for this important test a Harvey process plate was submitted by them. We would again finally express the wish that we could try the powers of other projectiles besides those of Holtzer. He himself has protested against his 6 in. shot—delivered in 1889—being taken as a sample of what he could now supply, excellent as they were for their day. Cannot Elswick supply us with some of its Wheeler-Sterling shot? It is only fair to our own plates to forestall the objection which will naturally be made abroad to calculations based on our trials made with Holtzer shot only.—*Engineer.*

Test of Hadfield Projectiles.

Every Englishman should be glad to learn that Hadfield's armor-piercing shot have attained successful results. It is undoubtedly our duty to secure anything good for our Navy that may be developed abroad, but we must naturally be best pleased when home manufacture comes to the front. Hadfield stands in a unique position in the development of projectiles by English processes, for though long ago Firth made steel shot, and Whitworth for a time stood unrivaled, for many years past we have chiefly depended on Holtzer's shot, made abroad, and on projectiles made by Firth or Elswick on the Firminy process. The supply of English projectiles made wholly on English processes long depended, we

think, on Mr. Hadfield alone, though latterly Colonel Bainbridge has made excellent shot at the Royal Laboratory. To speak plainly, for a long period we neglected to encourage the manufacture of armor-piercing shot. Had it not been so, Whitworth would not have given it up. Our own Royal Laboratory was not allowed to make them, and for many years Hadfield, under great discouragement, pushed on experiments with cast steel and with steel alloyed in various ways, and latterly with shot with heads of different forms. We are now glad to give the following account of recent successful trials made with Hadfield shot: "Two 6-in. Hadfield projectiles, of special design and quality, and with caps on their points, were fired, with a velocity of 1960 ft. and 1940 ft. per second, at a large Harveyed steel plate 8 ft. sq. and 6 in. in thickness. The plate on its upper surface had before received two 6 in. forged steel shots, neither of which had penetrated more than about 2½ in. There remained about 70 per cent. of the plate area untouched and uninjured. In both cases the projectiles pierced the 6 in. plate and 2 ft. of wood backing, and were found 15 ft. to 20 ft. at the rear of the sand butt. Though broken, the wreckage and destruction of timber, bolts and fastenings caused by the projectiles were specially great, showing the considerable remaining energy they possessed after passing through the plate itself. If this had been on a ship's side the damage done would have been very serious, the broken portions, not one of which was found on the front side, acting as mitraille, as was proved by the shattered condition of the surroundings and the backing." A Hadfield 6-in. projectile was also fired against a 9-in. special steel and water-hardened Sheffield plate, which it perforated completely, being recovered unbroken 20 ft. in rear.

Strange as it may appear, we think more highly of the perforation of the 6-in. Harveyed plates than of the 9-in. plate, believing the latter to be probably of the same kind as has been perforated by a Royal Laboratory 6-in. shot. On the face of it, as our readers may see, the 9-in. plate which allowed the shot to pass through unbroken must be very inferior in quality to the 6-in. Harveyed, which, although perforated, broke the shot in their passage. The fact is that this is an illustration of what very great differences exist in the resisting power of plates, and how much is due to the precise effect produced by the Harvey or Krupp process. The difference between a tool with a broken point and an unbroken one is naturally very great, and this is what is implied in the action on the shot of a really first-class face as compared with one less good.

Taking the result on the 6-in. Harveyed plates, then, as the more trustworthy and severe test, we have a very good result. It is difficult to compare it fairly with foreign trials. In the United States Wheeler-Sterling shot have done apparently more, a year or two ago, and Hadfield's shot without caps obtained a good result at Portsmouth, but probably Harveyed armor has improved since then, or it would not be a great boast that a capped Johnson 6-in. shot had perforated a 7-in. Harveyed plate with some little deformation. We trust that we shall hear of continued success with Hadfield projectiles, not only on the maker's own account, but for the credit of our country.—*Engineer.*

SHIPS OF WAR.

[Argentine.]

Training Ship Presidente Sarmiento.

The navy of the Argentine Government is about to be strengthened by the addition of a vessel floated from one of the building docks at Messrs. Laird Brothers, Birkenhead Ironworks, on Tuesday, August 31. This ship has been specially designed by the builders for service as a naval training or school ship, in the carrying out of which the builders have been in constant communication with officers of the Argentine Naval Commission, of which at present Captain Don Onofre Betbeder is chief. The vessel is named the Presidente Sarmiento. The approximate dimensions are: Length, 270 ft.; beam, 43 ft.; displacement, about 2750 tons; her draught of water will not exceed 20 ft.

The hull is of steel, built with a double bottom, and very carefully subdivided into twenty-four principal water-tight compartments, with coal protection along the machinery spaces. The bottom is sheathed with teak to 4 feet above the water-line, and coppered. The stem, stern and rudder frames are of bronze. She has a clipper bow, a handsome stern with gallery and stern walk, poop, forecastle and steel plate bulwarks, the material and workmanship throughout being equal to the requirements of the British Admiralty. The accommodation is specially roomy and well ventilated, and the sanitary arrangements are of the newest type, and provided for a total number of 400, each rank having separate and specially allocated quarters. Workshops are provided for each class of midshipmen and apprentices, and are suitably supplied with machine tools, &c. She is full ship-rigged, carrying a large spread of canvas, as it is intended to do a great part of her cruising under sail; and in view of this she is fitted with a Bevis feathering propeller. The boat equipment, which includes two steam launches, is on an ample scale.

The engines are direct-acting inverted triple compound, driving a single feathering screw propeller of sufficient power to give a speed of thirteen knots per hour. The boilers are four in number, each pair being in a separate water-tight compartment with its coal supply; two of them are of the Niclausse type and two of the ordinary cylindrical tubular type, and in addition there is a separate boiler for auxiliary purposes. The distillers are of very large capacity and are in duplicate. The electric light installation is also in duplicate, whilst there is a powerful refrigerating apparatus and chamber. The armament, which is of the most modern type, Elswick and Nordenfelt, comprises five 4.7-in., two 14-pounder Maxims, four 6-pounders, four 3-pounders, and other subsidiary guns, as well as three torpedo tubes. The ammunition hoists are to be worked electrically, and all means of transporting ammunition and projectiles are of the latest type. There will be two powerful search-lights, as well as special system of signals.—*Engineering.*

[Austria.]

The Zenta.

The torpedo cruiser Zenta was launched at Pola, August 18. She is of the modified Panther type; built of Siemens-Martin steel, she is 315 feet

long, 38 feet beam, 14 feet draught, of 2326 tons displacement. Two triple-cylinder engines, Yarrow water tubular boilers, developing 7800 horse-power, giving a speed of 20 knots. The normal coal capacity of 472 tons permits a radius of action of 3800 miles at 12 knots speed. The armament to consist of eight 4.7-inch, 40-caliber rapid firers, and ten 47-mm. R. F. guns, two gatlings and two 18-inch torpedo tubes.—*Le Yacht.*

[England.]

New Constructions.

Messrs. Vickers, who lately purchased the Naval Construction and Armaments Company's works at Barrow-in-Furness, have secured the contract for the new battle-ship of the Canopus class authorized to be constructed in a private establishment under the naval programme for 1897-98. The dimensions of the new vessel are: Length, 390 feet; beam, 74 feet; width, 43 feet; and displacement, 12,950 tons, on a mean draught of water of 27 feet 6 inches. The broadsides are to be protected by a 6-inch Harveyized armor, composed of an alloy of steel, nickel and chromium. The armament will comprise four 12-inch 46-ton breech-loading weapons, mounted two in each barbette; twelve 6-inch 100-pounder Q. F. guns, mounted three on either broadside, two for direct fire ahead and two for direct fire astern; and twelve 12-pounder Q. F. guns, besides four submerged torpedo tubes for the discharge of Whitehead torpedoes. In the design of the vessel speed has been considered to be an important item, and engines of the triple-expansion type will be provided to develop 13,500 H. P. when running at about 110 revolutions. The engines will drive twin screws, and each set will have cylinders of 30 inches, 49 inches and 80 inches diameter respectively, with a stroke of 51 inches. The boilers, twenty in number, will be of the Belleville type, with economizers, the total grate area of the boilers being 1050 square feet, and the heating surface about 34,000 square feet. The new ship is to be called the Vengeance.

According to the statement of the First Lord in Parliament, the other three new battle-ships, which are to be built at Portsmouth, Chatham and Plymouth respectively, are to be Majestics of an improved type, bringing the number of that formidable class up to twelve. Their dimensions will be as follows: Length, 400 feet (10 feet more than the Majestic); beam, 75 feet; mean draught, 26¾ feet (9 inches less than the Majestic); with a displacement of 14,900 tons; their mean speed with natural draught is to be 18 knots, or 1½ knots more than the Majestic; and they are to have an estimated continuous speed in smooth water, with clean bottoms, of 16½ knots. The ship will be fitted with water-tube boilers, the coal supply and bunker capacity being the same as in the Majestic. Their armament is to be identical with that of the Majestic, but new and powerful types of 12-inch and 6-inch guns will be provided, and improved mountings will be introduced. The hull armor, or citadel, will be of the same extent and thickness as in the Majestic, but the quality of the armor will be superior. The armor is to be of nickel steel, and the quality is so superior that the protection, buoyancy and stability of the vessel will be sensibly increased. A new feature in these ships is that before and abaft the citadel armor the sides will be protected by thin armor, as in the Canopus class. The protection of the barbettes containing the 12-inch guns and the protection of the 6-inch Q. F. guns will be

equal to that of the Majestic class, and the arrangements for the stowage and transport of ammunition will resemble those of that class.

The new light-draught river gunboats are to consist of six vessels of 100 feet length, 2 feet draught, and a maximum speed of 9 knots; two vessels of about 145 feet length, 2 feet draught, steaming 13 knots; and four twin-screw river gunboats of 180 feet length, 8 feet draught, and a maximum speed of 13½ knots.

The general dimensions of the new Royal yacht are to be: Length between perpendiculars, 380 feet; beam, 50 feet; mean draught, with keel, 18 feet; displacement, about 4600 tons. The hull will be of steel, with minute subdivision into numerous water-tight compartments, and a cellular double bottom as an additional security, and for the purpose of maintaining speed at sea for considerable periods the steel hull will be sheathed with teak planking covered with copper. The vessel will be propelled by twin screws, actuated by vertical triple-expansion engines, and the maximum speed on the contractors' eight hours trial will be 20 knots.

Four new armored cruisers of quite a new type are also to be laid down, these vessels being in addition to the programme as already presented to Parliament; their dimensions being as follows: The length between the perpendiculars, about 440 feet; the extreme beam, 69½ feet; the mean draught with keel, 26 feet; and the displacement, 11,850 tons. Armament: two 9.2-inch guns and twelve 6-inch Q. F. guns, these being of a new and more powerful type; fourteen 12-pounder Q. F. guns, with a certain proportion of smaller Q. F. guns and two submerged torpedo tubes. The protection of the 9.2-inch and 6-inch Q. F. guns will be equal to that of the Powerful class, but the quality of the armor will be superior. Arrangements for the supply of ammunition will be similar to those in the Powerful and Diadem classes. Protection to the buoyancy and stability will be secured by vertical armor of the same thickness and quality as in the Canopus class of battle-ship. The protective decks will be similar to the Canopus class. The steel hulls will be wood-sheathed and coppered, so that the vessel may keep the sea for long periods without serious loss of speed. The measured mile speed, with natural draught, on an eight hours' trial, will be about 21 knots. Water-tube boilers will be adopted, and the continuous sea speed in smooth water and with clean bottoms will be about 19½ knots. The coal bunker capacity will be about 1600 tons, half of this being carried at the above-stated draught and displacement. All four ships are to be built under contract.—*Journal Royal United Service Institution.*

Warships under Construction.

In order to afford a comprehensive view of the shipbuilding in progress throughout the United Kingdom, the following statement of the war vessels which are at present under construction has been compiled. For this statement it has been assumed that a vessel may be regarded as "under construction" from the commencement of the laying of her keel to the time when she is ready for her steam trials. Of course, when this latter stage is reached the guns have usually still to be placed on board and the vessel to be fitted out before she is ready to be commissioned; but she is, nevertheless, structurally completed:

British.	No.	Displacement. Tons.
First-class battle-ships	8	109,450
First-class protected cruisers	8	88,000
Second-class protected cruisers	7	40,000
Third-class protected cruisers	7	14,945
Torpedo-boat destroyers	30	10,000
Total	60	262,395

Foreign or not stated.	No.	Displacement.
Armored vessels	6	49,380
Protected cruisers	7	27,870
Torpedo-boat destroyers	13	4,340
Torpedo-boats	6	750
Other vessels	1	2,460
Total	33	84,800
British and Foreign total	93	347,195

—*Steamship.*

Le Yacht, in commenting in its issue of July 3, 1897, upon the wonderful increase in England's navy, shows the following comparison between the reviews of Spithead in 1887 and 1897:

	1887	1897
Battle-ships	27	25
Large cruisers	none	12
Smaller cruisers	14	54
Gunboats	31	20
Destroyers	none	30
Torpedo cruisers	38	20
Personnel	15991	36565
Guns	441	2147
Total number of ships	110	161

A glance at the table will show the enormous increase in the number of cruisers; instead of the 14 cruisers present in 1887, we find 66 in 1897, and among the latter 12 armored cruisers of enormous tonnage, such as the Powerful and Terrible. Ten years ago England did not possess two cruisers for each battle-ship, to-day she has more than four cruisers for each battle-ship. France can only muster 1.6 light ships for each battle-ship.

The Panther.

Messrs. Laird Brothers, of Birkenhead, had, on the 4th July, a highly successful trial of H. M. torpedo-boat destroyer Panther on the measured mile at Skelmorlie. The vessel attained the highest actual speed yet recorded for the mean of six runs on the mile, namely, 30.52 knots; and for three hours' continuous steaming she maintained 30.16 knots. After the speed runs, steering, anchor, and stopping and starting trials were completed. There was no hitch of any kind. The vessel returns to Birkenhead for completion, and will shortly leave for Devonport Dockyard.

The Bat.

The Bat, torpedo-boat destroyer, built by Messrs. Palmer, of Jarrow, carried out her second stipulated three hours' 30 knots trial at Portsmouth on July 14th under the command of Staff-Com. Hire. During the three hours she had six runs over the measured mile, and the best run, with wind and tide, gave her a speed slightly exceeding 32 knots, but the mean of the three hours was 30.229 knots. She maintained an average indicated horse-power of 6189, which enabled her to keep up 400 revolutions. The air pressure in the cylinders was 3 in., the steam in the boilers 250 lbs., and the steam in the engine-room 233 lbs. The trial was in every respect satisfactory.

The Mallard.

The Mallard, torpedo-boat destroyer, went out from Chatham for a three hours' coal-consumption trial on September 7th. The results were satisfactory. The steam pressure in boilers was 211 lbs. per square inch, with an air pressure in stokeholds of 2.87 in., and the revolutions per minute were 398.1 starboard and 395.9 port. The engines developed 5749 horse-power, and the ship attained a mean speed on the three hours' continuous run of 30.201 knots, and a speed of 30.794 knots as a mean of six runs on the measured mile. The coal consumption was economical. The Mallard, which was built by Messrs. J. I. Thornycroft & Co., will now be prepared for her second series of trials.

[France.]

L'Amiral Pothnau.

This first-class armored cruiser attracted much attention at the naval review at Spithead. She is 360 feet long, 50 feet beam, 21 feet 4 inches average draught. Normal displacement, 5320 tons. The armament consists of two 7.4-inch guns in turrets, ten 5-inch guns in casemates and many of smaller calibre. In the 24 hours' trial, under natural draught, the engines developed 6845 horse-power, giving an average speed of 17.787 knots, the consumption of coal being 791 grammes per I. H. P. With forced draught 10,200 horse-power was developed and a speed of 19.2 knots. She has three funnels and two military masts.

D'Entrecasteaux.

Further details in the armament of the D'Entrecasteaux show that the eight 5-inch guns of the lower tier are each mounted in a separate armed redoubt. The guns are of 1893 model, 45 calibres, central pivot mounts. The ammunition hoists are worked either electrically or by hand. The guns can be trained by electricity as well as by hand. The arrangement of the battery gives a bow or stern fire of six 5-inch and one 9.4-inch guns, and a broadside fire of two 9.4-inch and six 5-inch guns. The turrets are worked by electricity, but can be turned by hand.—*Le Yacht.*

Dupetit-Thouars (C_3).

According to *Le Yacht* of August 28, orders have been received at Toulon for the construction of a new cruiser to be named Dupetit-

Thouars. She is to be a first-class armored cruiser to replace the Jeanne Bart type provided for by this year's budget. She is to cost about 20 million francs and is designed by M. Bertin. Her principal dimensions are: Length, 452 feet; beam at water-line, 63.6 feet; maximum beam, about 2 feet above water-line, 64 feet; draught, 23 feet; displacement, 9516 tons; speed at forced draught, 21 knots. Three vertical triple expansion engines, each connected to a screw, to develop 19,600 horse-power, steam being supplied by 20 Normand water tubular boilers. The normal capacity for coal and liquid fuel is 1020 tons, giving a radius of action of 6500 miles at 10 knots. This can be increased to 1600 tons carrying capacity, giving a radius of 10,300 miles at 10 knots. The armament will consist of two 7.6-inch guns, one forward, one aft, in turrets; eight 6-inch rapid-fire broadside guns, in armored casemates, so arranged that four can fire ahead and four astern. Four 3.9-inch rapid-firers on the superstructure, two firing ahead, two astern. The secondary battery consists of sixteen 47-mm. and six 37-mm. rapid-fire guns. There are two submerged torpedo tubes. Six search-lights will be provided. A sister ship, the Amiral de Gueydon, is to be laid down at Lorient.

[Italy.]

Varese.

The armored cruiser Varese was launched July 25 at Leghorn. Length, 328 feet; beam, 60 feet; draught, 24 feet; displacement, 6840 tons. Two triple expansion engines, supplied by 8 tubular boilers, are to develop 13,000 horse-power, giving a speed of 20 knots under forced draught. Coal capacity, 1000 tons, besides liquid fuel. The armament to consist of two 10-inch guns in two armored turrets of 6-inch thickness, one forward and one aft; ten 6-inch guns in armored casemates; six 4.7-inch guns on the upper deck, protected by shields; ten 37-mm. guns, two gatlings, and five submerged launching tubes. An all-around water-line armor belt of 6-inch nickel steel, above which the battery belt extends for 60 metres and protects the bases of the turrets, with thwartship end belts of same thickness. The protective deck varies in thickness from ¾ to 1½ inches.—*Le Yacht.*

[Japan.]

Takasago.

This first-class cruiser was launched from the Armstrong works on May 29. She is a modified Yoshino type, length 360 feet, beam 46 feet, mean draught 23 feet, and of 4150 tons displacement. Protection is afforded by a steel protective deck running the full length of the ship, varying in thickness from 1.7 to 4 inches, and a conning tower of 3-inch steel. Two triple-expansion engines of 15,500 indicated horse-power are to give a speed of 24 knots. The armament to consist of two 7.8-inch, ten 4.7-inch, twelve 3-inch and six 47-mm. rapid-fire guns, besides five torpedo-launching tubes.—*Mittheilungen aus dem Gebiete des Seewesens.*

New Cruiser Building at San Francisco.

This second-class protected cruiser, building at the Union Iron Works for the Japanese Government, is an enlarged and improved Yoshino. She will have a length at load water-line of 396 feet, extreme beam of

49 feet, and 17 feet 7 inches draught at normal displacement of 4760 tons. The twin triple-expansion engines are to develop 15,000 horse-power, giving a speed of 22½ knots per hour. Steam is supplied by four double-ended and four single-ended boilers. The normal coal supply is 350 tons; bunker capacity 1000 tons. Protection to the machinery is afforded by outboard coal bunkers and a protective deck 4½ inches thick on slopes and 1¾ on top, extending full length of ship.

The use of non-inflammable wood serves as protection against fire. The armament consists of two 8-inch and ten 4.7-inch R. F. rifles, twelve 12-pounders and six 2½-pounders. The 8-inch guns, one aft, one forward, are protected by steel shields and have each a train of 270°. They are expected to throw four aimed shots a minute. The 4.7-inch guns are mounted in 3-inch armored sponsons, with shield protection on the main deck, with 100° arc of train. The 12-pounder guns are mounted two forward, two aft, the rest on main deck in broadside. The guns are Armstrongs. There are five torpedo tubes. A sister ship is building at Cramp's yard.

In addition, the following vessels are under construction abroad: The battle-ship Shikishima of 15,000 tons, 14,500 horse-power, 18 knots speed, to be completed in two years by the Thames Iron Works; a second at Thomson works, and a third at the Vulcan works. A cruiser of 4350 tons, 15,500 horse-power, 22 knots, building at the Thomson works, is to be completed this year. Also six destroyers of 30 knots, two at Thornycroft's, four at Yarrow's; five torpedo-boats of 24 knots at Schichau and five at Normand's.

Speed Trials of Battle-ship Yashima.

The Yashima, one of the two first-class battle-ships now completing in this country for the Japanese Government, has just made her steam trials at the mouth of the Tyne. She has been built by Messrs. Sir W. G. Armstrong, Whitworth & Co., of Newcastle-on-Tyne, in two and a half years, from designs by Mr. Philip Watts, the director of Elswick Shipyard. The excellence of the design has been fully proved by the splendid results obtained on the trials, not only as regards speed and endurance, but also in respect of her manœuvring qualities, which were admitted by all who witnessed them to be very exceptional.

Speed trials were made on several occasions, the first official trials taking place on the 13th of July. It consisted of a four hours' run under forced draught with an air pressure in the stokeholds corresponding to a head of 1½ in. of water. For some time during this run a speed of 19.5 knots was maintained, and the mean speed for the whole four hours was 19.227 knots; the mean horse-power developed was rather over 14,000. A trial of six hours' duration was afterwards made with open stokeholds, when a power of nearly 10,000 horses was developed. The mean speed over this period was 17.26 knots, but the mean of four runs over the Admiralty measured mile during the early part of the run gave a speed of 17.76 knots, and this speed could have been maintained during the whole run if it had been desired to do so. The mean speed obtained during the four hours' run with forced draught was nearly a knot in excess of the forced draught speed guaranteed by the contract; and even the mean speed obtained during the six hours' run with open stokeholds was half a knot in excess of the contract, whilst over the earlier part of the run it was a knot in excess of the contract.

The machinery worked with perfect smoothness and gave no trouble whatever, and the ship was practically free from vibration. It is needless to say that speeds one knot in excess of that promised in each case with forced and natural draught gave general satisfaction to the Japanese Commission, and the Japanese Government may be congratulated on possessing the fastest armored battle-ship afloat.

At the end of the natural draught trials, while the vessel was still at full speed, turning trials were made with the helm at various angles, and it was found that the vessel, with a length of over 400 feet over all, could turn in a circle of 180 yards in diameter, or less than one and a half times her own length, this was with the rudder hard over and both engines going ahead. This circle is, we believe, by far the smallest ever made by a vessel of this size, and is the result of having a large balanced rudder, carried low down beneath the stern, the dead-wood of which is very much cut away. This form has been adopted recently in all the Elswick cruisers, with such good results that it was determined to try it in the Yashima and in the Fuji.

The propelling machinery of the Yashima has been supplied by Messrs. Humphrys, Tennant & Co., of Deptford, and of the three-cylinder vertical triple-expansion type, the horse-power contemplated with forced draught being 14,000, and 10,000 with natural draught; and it is interesting to note that the trials were most successfully made after the engineers' strike had begun, Messrs. Humphrys thus losing the benefit of nearly all their best and most experienced hands, and being compelled to carry out the trials with a "scratch" crew. If it had not been for this, there can be no doubt that even better results would have been obtained.

Accounts of the principal features of the Yashima have already been published by us, but it will not be out of place to mention here that she is a vessel of 12,320 tons displacement, with a length of 372 feet between perpendiculars, beam 73 feet 6 inches, draught of water 26 feet 3 inches. She has a complete armored belt from 18 inches to 14 inches thick, and 14-inch barbettes, protecting two pairs of 12-inch guns, in addition to which she carries ten 6-inch quick-firing guns and numerous guns of smaller calibre.—*Engineer.*

[PORTUGAL.]

M. Croneau, French naval constructor, has undertaken the reorganization of the Portuguese dockyard. He is arranging for the building of a cruiser to be named the Rainha Amelia. She is to be 250 feet long, 36½ feet beam, and to have a displacement of 1660 tons. She is to be fitted with two triple-expansion engines of 3000 H. P., to give a speed of 16 knots natural draught, and with forced draught a speed of 17½ knots. Her armament to consist of four 6-inch, four 4-inch and two 47-mm. guns, all rapid-firers, two machine guns and two torpedo launching tubes.

[RUSSIA.]

THE TRIAL TRIP OF THE ROSSIJA.

On July 18th the first-class cruiser Rossija began her official full-powered trials on the measured mile. The port and starboard engines working together, were first tried, the trial lasting 6 hours. With these two engines, while steaming continually, ten trips each of four miles were made. The mean speed of the cruiser with an average of 83½ revolutions and a steam pressure of 21.8 pounds per centimetre was 19.74 knots. The greatest speed reached was 20.25 knots. The draught

of the ship during the trial was from 27.5 to 26 feet, with a displacement of 12,130. The four-bladed screws had a pitch of 8.4 metres and a diameter of 6.1 metres. The engines worked very satisfactorily, making five revolutions more than contracted for, viz., 80.

The trial of the middle engine, with a Bavis propeller of 4.6 metres pitch, lasted two hours. With this engine under full steam the cruiser made three trips, reaching a mean speed of 9.94 knots. The engine averaged 99.8 revolutions with a steam pressure of 21.8 pounds per square centimetre. The I. H. P. of the lateral engines, computed from 7 series of diagrams, was 15,697; that of the middle engine, the average of five series of diagrams, was 2749.7. The contract required 14,500 I. H. P. for the lateral engines and 2500 for the middle engine—*Marine Rundschau.*

[Spain.]

The Pelayo.

The Pelayo is practically being rebuilt at the La Seyne works. In the first place the old boilers are being replaced by Niclausse boilers, with a saving of weight of 250 tons, which gain is to be devoted to strengthening the defensive strength of the ship. These alterations will take several months; they will consist notably in the construction of an armored redoubt, a cofferdam, and enlargement of the fresh-water system. Rapid-fire guns are to be substituted for the old battery, changes in the ammunition supply will be made, and the radius of action of the vessel will be generally enlarged.—*Le Yacht.*

[United States.]

Holland Submarine Boat Plunger.

The Holland torpedo-boat Plunger was successfully launched at the yard of the Columbian Iron Works, Baltimore, Md., on August 7. Her length is 85 feet and diameter 11.5 feet. Her displacement when floating light is 155 tons, and when down to her load water-line the displacement is 160 tons. Two sets of motive power are provided, one for the afloat and awash condition, and one for the submerged condition. Twin quadruple expansion engines, with steam furnished from a water-tube boiler, will operate twin screws when afloat or awash, and a 70-horse-power motor, fed from forty-eight chloride cells, will furnish the power when submerged. The steam power, electric dynamo and storage cells are so connected as to be readily reversible in their action, thus rendering it possible to recharge the cells from the dynamo, the steam engine being used as a prime motor. The electric power may also be connected to a propeller shaft placed in the axis of the boat, in addition to the connection with the main propeller shafts. The motor may thus operate a special propeller, in addition to driving the main shafts independently of the steam engines. The capacity of the storage cells is amply large to prevent injury or deterioration while giving off the power required to propel the vessel—a speed of about 8 knots for at least six hours. It is confidently predicted that the vessel will reach a speed of 16 knots in the light condition, while she will be able to reach 15 knots with three feet of water covering the hull, while not less than 8 knots while submerged will be acceptable. At these speeds an endurance of 15 hours awash and 10 hours submerged is anticipated. She will carry no guns or other armament except five automobile torpedoes, to be launched from two expulsion tubes. Two additional torpedoes can be carried, if desired.

BOOK NOTICE.

The marine number of Cassier's Magazine, published in August of this year, is a most interesting addition to marine and professional literature. The contributors are the highest authorities on the subjects dealt with, and their names are in themselves sufficient guarantee to commend this collection of valuable papers.

The contents are as follows: Specialties of warship design, by Sir William Henry White. Fast torpedo-boats, by A. F. Yarrow. The problem of steamship design, by Henry H. West. The launching of a ship, by Robert Caird. Hydraulic principles affecting a floating ship, by F. P. Purvis. Marine boiler furnaces, by D. B. Morison. Steamers for shallow waters, by John J. Thornycroft. The design and building of a steamship, by Archibald Denny. Water-tube boilers for war vessels, by Walter M. McFarland. The naval weakness of Great Britain, by Sir Charles W. Dilke. The modern marine engine, by Charles E. Hyde. American sound and river steamboats, by Leander N. Lovell. The auxiliary machinery of an American warship, by F. Merriam Wheeler. Shipbuilding and transportation on the great American lakes, by Joseph R. Oldham. Steel for marine engine forgings and shafting, by R. W. Davenport. The coaling of steamships, by S. Howard Smith. Submarine navigation, by John P. Holland.

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AUGUST 27. Recent Armor Trials. France and her Navy.

SEPTEMBER 3. The Manchester Ship Canal. Shipbuilding and Marine Engineering on the Thames in the Victorian Era. The Argentine Training Ship Presidente Sarmiento. Floating Dry Dock for Cuba.

SEPTEMBER 10. Engines of the S. S. Empress Queen. Modern Japan. Recent Trials of Hadfield's Projectiles. Improved Lathe for Turning Projectiles.

ENGINEERING.

JUNE 11, 1897. Tolch's Reversible Propeller. The Battle-ship and the Torpedo Vessel. The Boilers of H. M. S. Spanker.

JUNE 18. Shipping and Naval Matters in Japan. Test for Marine Barometers. Signalling through Space without Wires.

JULY 2. The Naval Review. The Turbinia Shipbuilding Materials and Workmanship.

JULY 9. The International Congress of Naval Architects and Marine Engineers. Non-flammable Wood.

JULY 16. Crank and Propeller Shafts. High Speed Screw Propellers. Skin Resistance.

JULY 23. Kermode's Steam Steering Gear. The Mathematical Theory of Naval Architecture. On Dynamos.

JULY 30. Light-house Illumination in Japan. Armor Plate Press. High Explosives. The Navy Estimates. Hardened Plates and Broken Projectiles.

AUGUST 6. The Yashima.

AUGUST 13. Water-tube Boilers in High Speed Ocean Steamers. Forced Circulation Fuel Economiser. Hardened Plates and Broken Projectiles. High Speed Self-lubricating Steam Engines. The Mathematical Theory of Naval Architecture.

AUGUST 20. The Maxim-Schupphaus Smokeless Powder. The Mathematical Theory of Naval Architecture. A Portable Recorder for Tests of Metals.

AUGUST 27. Large Explosions and their Radii of Danger. The Maxim-Schupphaus Smokeless Powder and Aerial Torpedoes. The Mathematical Theory of Naval Architecture.

SEPTEMBER 3. Large Explosions and their Radii of Danger. Trials of Armor Plates. Coloring Steel. On Dynamos.

SEPTEMBER 10. Large Explosions and their Radii of Danger. Floating Dock for San Paulo de Loanda. Japan and Formosa. Deflection in Steamers. The Diffusion of Sulphide through Steel.

TRANSACTIONS OF THE INSTITUTION OF NAVAL ARCHITECTS, 1897.

The Maritime Position and Principal Features of the Port of Hamburg. Shipbuilding in Germany. Recent Improvements in Docks and Dock Appliances. Development in Design and Construction of German Men-of-War. Classification and Rela-

tive Power of Warships. On Signs of Weakness in Tank Steamers. On Various Descriptions of Doors applicable to Water-tight Bulkheads, their Fastenings, etc. Use of Electricity on Board Ships. Recent Trials of the Cruisers Powerful and Terrible. Water-tube Boilers in Warships. A Mechanical Method of Ascertaining the Statical Stability of Ships. On the Fighting Value of certain of the older Ironclads if re-armed. The Application of the Compound Steam Turbine to the Purpose of Marine Propulsion. On the Use of the Water-line in Designing the Lines of Ships. The Accelerity Diagram of the Steam Engine. A Note on the Geometry of Stability. Acetylene Gas and its Probable Future Afloat. Nickel Steel as an Improved Material for Boiler Shell Plates, Forgings and other Purposes. Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding.

THE STEAMSHIP.

JULY, 1897. The Boyle System of Ship Ventilation. Improved Materials and Shipbuilding Design. The New North German Lloyd Atlantic Steamer Kaiser Wilhelm der Grosse. Unusual Corrosion of Steel Vessels. The Future of the Torpedo.

AUGUST. Recent Improvements in Pumping Machinery for Marine Service. The Babcock and Wilcox Water-tube Marine Boiler. History and Progress of Marine Engineering. Non-flammable Wood.

SEPTEMBER. Mean Pressure Indicator for High Rotational Speeds. New Type of Self-trimming Steamer. Marine Boiler Explosions. An Efficient Steam Saver. High Speed Self-lubricating Steam Engines. Crank and other Shafts used in the Mercantile Marine. Designing a Steamship. Some Impressions of the Spithead Naval Review. Robey & Co.'s High Speed Engines. The Collapsible Boat Chock (Hamlyn's Patent). Propellers for Shallow-draught Steamers. The Dangers of Coal Cargoes. Fast Torpedo-boats. The Training of Engineers. Launch of Largest Steamer ever built at West Hartlepool.

MORSKOI SBORNIK.

MAY, 1897. Exploration in the Arctic Ocean. Future Naval Warfare. Comparative Strengths of the Fleets of the Three Naval Powers. Construction and Trials of Triple-screwed Cruisers. The Mounting of Search-lights on Ships.

JUNE. Discussion of Problems of Naval Tactics. Comparisons of American and British Ironclads. Steam Iceboat "Nadejnie." Notes on Metallurgy. Damage to the Steam Cylinder of the Torpedo-destroyer Star. Mishaps to Torpedo-boats Corrientes and Santa Fé. Discussion of Problems in Naval Tactics:

Organization of Fleets in the Future. Development of the Fleets of the Principal Naval Powers. Why it is disadvantageous for Russian Merchant Ships to navigate under the Russian Flag. Electro-motors. Present Status of the Theory of Ocean Currents. J. B. B.

RIVISTA MARITTIMA.

JUNE, 1897. Notes on the Proper Employment of Torpedo-boats. The Blechynden Boiler. The German Navy. The Maritime Laws of Ancona. Naval Armor:

This is an exhaustive article on armor tests of recent dates in Europe and America. The tests are tabulated and comparisons are made. An appendix investigates and compares the formulas for perforation adopted by different governments.

H. G. D.

ANNALES DU CONSERVATOIRE DES ARTS ET MÉTIERS.

2D SERIES, VOL. 8. Salubrity. Application of Electrolysis to Metallurgy. Life and Works of Olivier. Life and Works of La Gournerie. Researches upon the Instruments, Methods and Drawings of Topographical Work. A Projected Astronomical Observatory in Tunis. Bridge Building in America.

LE YACHT.

JUNE 5, 1897. Composition of Crews for Service in the Far East. The English 30-knot Destroyers. New Semaphore Signals.

JUNE 12. Comparison of Trial Trip Results. Gun and Armor with reference to Capped Projectiles.

The idea of using capped projectiles was first conceived by Admiral Makharoff of the Russian Navy. Trials at Ochta proved the increased facility in penetration with such projectiles. Experiments are being made in France in this direction. Two French firms, that of Saint Chamond and that of Unieux, are supplying projectiles capped on different systems. Saint Chamond use a light cap soldered to the ogive. Unieux secure the cap by slight projecting lugs on the ogive. In both of these systems, like that of Johnson, the aim is to merely secure the cap sufficiently so as to adhere to the point of the projectile after firing and until impact on the plate.

There are various theories advanced to account for the effect of the cap in increasing penetration. One of the French theories is that the cap first acting upon the hardened surface of the plate, slightly depresses it or cuts into the thin hardened face, so that the point of the projectile remains intact after it has passed the hardened face, permitting it to act more efficiently upon the softer non-hardened part of the plate.

Germany's Naval Strategy.

JUNE 19. The French Fleet compared with the Fleets of the Triple Alliance. The Naval Review at Spithead.

JUNE 26. The Naval Review at Spithead. The Report of M. Mahy on the Naval Credits.

JULY 3. After the Review at Spithead. New English Vedette Launch. French Naval Manœuvres in 1897. The Cruiser Pothnau.

JULY 10. The U. S. Battle-ships Wisconsin, Illinois and Alabama. Submarine Navigation.

JULY 17. The French Naval Manœuvres.

JULY 24. The English Naval Manœuvres. The French Manœuvres.

JULY 31. England's Sea Power. The French and English Naval Manœuvres.

AUGUST 7. The English Admiralty and New Naval Constructions. Perforated Sails.

The captain of the Italian ship Macdiarmid reports upon experiments made with the perforated sails of Vassallo system and increased speed obtained by their use. The Macdiarmid made the voyage from Cardiff to the Cape of Good Hope in 46 days, overhauling and passing more than 30 vessels bound the same way. From the Cape to Newcastle, Australia, took her only 35 days.

The Naval Manœuvres. The Turbinia's Engines.

AUGUST 14. The New English Navy Credits. The French Naval Manœuvres. The Parasol Boat. The Danish Cruiser Heimdal.

AUGUST 21. England's Naval Strength. The Squadron of the North at St. Malo. The Large English Cruisers, Diadem Type.

AUGUST 28. The Accident to the Bruix. New Site for French Trial Trips.

SEPTEMBER 4. Admiral Colomb on the Future of the Torpedo. The Injeniero Hyatt. The Sissoi-Veliky.

H. G. D.

LE MONITEUR DE LA FLOTTE.

JULY 17, 1897. The Grand Manœuvres. The Naval Budget. English Naval Manœuvres.

JULY 24. Towards the Poles. The Navy in Parliament. The Naval Manœuvres.

JULY 31 AND AUGUST 7. The Naval Manœuvres. Incombustible Wood.

AUGUST 14. The Seigle Boiler. The Yena.

AUGUST 21. Apropos of the Grand Manœuvres. The Accident to the Bruix.

AUGUST 28. M. Faure in Russia. The Accident to the Bruix.

REVUE DU CERCLE MILITAIRE.

JUNE 12. The Military Lessons of the Chinese-Japanese War.

JUNE 19. England's Naval Strength in the Indian Ocean. General Champion de Nansouty.

JUNE 26. Reorganization of the Italian Army. Entrance of German Naval Cadets.

JULY 3. Urgent Infantry Reforms. Reorganization of the Italian Army.

JULY 10. The German Army in 1897. Urgent Infantry Reforms (continued). Sautter-Harlé Dynamos for Torpedo-boats.

JULY 17. The Old and the New Russian Infantry Regulations. Scientific Branches and Schools of Instruction of the Spanish Navy. Urgent Infantry Reforms (continued).

JULY 24 AND 31. The Madagascar Expedition of 1895. Urgent Infantry Reforms (continued). Admission to the French War College. England's Naval Supremacy.

AUGUST 7. The Madagascar Expedition of 1895. The Alpine Manœuvres.

AUGUST 14 AND 21. The Alpine Manœuvres (continued). Urgent Infantry Reforms (continued). The Russian Grand Manœuvres. Italy's Experiment in Mobilizing the Fleet.

AUGUST 28-SEPTEMBER 4. The Madagascar Expedition of 1895 (continued). Urgent Infantry Reforms (continued). Reorganization of the Italian Army.

REVUE MARITIME.

MAY, 1897. Boiler Feeds. Aerial Currents, their Direction and Utilization by Aerostats. The Oceanographers of France. Value of Ships-of-War from an Artillerist's Point of View. Rambowed Cruisers in England. Tests of Dürr Boilers. Naphtha Fuel in the Russian Navy. Various Devices for Lessening Dangers of Collision.

JUNE. Boiler Feeds (concluded). Statistics on Shipwrecks for 1894. Aerial Currents, their Direction and Utilization by Aerostats. The English Naval Budgets, 1897 to '98. The Prince George. Trials of the Turrets of the English Battle-ship Caesar. The Brown Segmental Gun. Victory of Projectile over Armor. Test of Experimental Turret in the United States. Promotions in the Italian Navy.

JULY. Statistics on Shipwrecks for 1894. Vice-Admiral Magon. Aerial Currents, etc. Preparation for Naval War. The Pelorus. The Military Value of Old English Armor-clads with New Batteries. The German Naval Budget, 1897-98.

AUGUST. Statistics on Shipwrecks for 1894. Vice-Admiral Magon (concluded). Aerial Currents, etc. (concluded). Naval Policy. Germany's Naval Policy and Strategy. Trials of the Powerful and Terrible. H. G. D.

BULLETIN DE L'ASSOCIATION TECHNIQUE MARITIME NO. 7, SESSION DE 1896.

Theory of Pitching in a Seaway.
The Effect upon Stability of a Liquid Cargo.
Changes in Immersion, Stability and Trim experienced by a Vessel Floating on Liquids of Different Density.
Calculation of the Pressure Moment on Rudders.
Conversion of a Compound Engine designed for a Pressure of 71 lbs. into a Compound Engine for 171 lbs.
Naval Warfare.
Development of Navies during the Past Ten Years.
Shallow Draft Vessels with Screws in Funnels.
Derelicts.
Nautical Terminology.
Evaporators.
The Niclause Boiler.
The New Belleville Boilers.
Certain Special Steels. R. P. H.

MARINE RUNDSCHAU.

JULY, 1897. The History of the Fleet (continued). The Line-of-Battle Ships of the Century (with sketches). The New Rules of the Road at Sea. English Plans to open up Hudson Bay. Report of the Commanding Officer of the Möwe on the Attack by Natives of Aly Island upon a Surveying Party. French Fisheries on the Coast of Algiers and Tunis. Naval Notes.

AUGUST. The History of the Fleet (continued). Retrospect of the Past Services performed by the Warships Freya, Luise and Nautilus. Reports from Imperial Ships.

Report of the commanding officer of the Brandenburg upon the bursting of a steam pipe. Report of commanding officer of the Kaiserin Augusta on coaling ship in the Mediterranean: "In Malta the coaling was done by the coal firm's force, being handled in baskets holding about 88 pounds each; 716 tons were taken on board in 5½ hours. The firm guarantees its ability, with its own force, to deliver 1000 tons on board in six hours, or 2000 tons in a day. At Crete, coaling from a steamer alongside, with the ship's company, 410 tons of coal were taken on board in 10 hours, or an average of 41 tons per hour. On April 8, in the same harbor, 471 tons were taken on board in 9 hours, and on May 13, at Phaleron, 508 tons in 8 hours, averaging 64 tons an hour. This means that every man engaged had to handle over 200 cwt., transporting it about three meters in height and 50 meters of length."

Report of the commanding officer of the Bussard on the use of retarders on board the steamer Tavinni.

Tests of Belleville Boilers. Contributions on Nautical Astronomy. Pictures from the History of the Hansa. Naval Notes.

SEPTEMBER. The History of the Fleet, Supplement to the Line-of-Battle Ships of the Century. The Hydrographic Office of the British Admiralty. Reports from Imperial Ships.

Report of the commanding officer of the Möwe of the punishment of the natives of Aly Island.

Trial Trips of the Aegir. Finding Positions by Means of the Marc St. Hilaire Method, with especial Reference to Sources of Error. Naval Notes. H. G. D.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

Vol. XXV., No. 7. The French Naval Manœuvres of 1896. Dip Observations in Order to Determine the Refraction Coefficient. Construction and Efficiency of Boilers. The English Battle-ships of the Majestic and St. George Class. Niclaus Boilers on the Spanish Cruiser Cristobol Colon. Foreign Naval Notes.

No. 8. The Battle of Lissa, 1811.

Gives a full description of the battle, its results, and review of preliminaries.

The Influence of Winds and Atmospheric Pressure upon the Tides. The Seychelles. Steam Trials with Temple-Guyot Water-tube Boilers. On a Formula for Reduction of Circummeridian Altitudes. Compound Steam Turbines applied to Boat Propulsion. Foreign Naval Notes.

No. 9. Alternating and Direct Currents. Italy's Fleet Manœuvres. Telegraphy without Wires, Marconi System. Disabling of Ships by Gun-fire. Foreign Naval Notes.

H. G. D.

DEUTSCHE HEERESZEITUNG.

No. 51, June 26, 1897. Firing Development and Fire Discipline for Infantry.

Nos. 53 and 54. Regulations for Manœuvres of Russian Infantry. The Fighting Tactics of the French Infantry.

Nos. 55 and 56. Japan's Naval Construction Programme, 1896 to 1906. The Initiative in the German Grand Manœuvres. English and French Fleet Manœuvres.

Nos. 60 and 61. A Fleet for Defense or Offense? Organization and Tactics of Mongolian Cavalry. Questions of Modern Artillery Combat.

Nos. 62 and 63. Questions of Modern Artillery Combat. Launch of the O'Higgins.

Nos. 64 and 65. Questions of Modern Artillery Combat. New English Warships.

No. 66. Questions on Artillery Tactics. Military Instructors for Corean Army.

No. 67. The Eclaireurs of the French Infantry. Questions of Modern Artillery Combats.

No. 68. New Russian Infantry Regulations. The Eclaireurs of the French Infantry. Questions of Modern Artillery Combats.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

No. VI., 1897. Description of two Hurricanes encountered on the Way from Singapore to Yokohama. Storm Signal System in Holland. Useful Tables to Compute Time of Star Occultations for 1898. New Cloud Pictures. Nautical Tables.

No. VII. Hydrographic Observations on the Route from Yokohama to Nagasaki. Sailing Directions for the Pacific Ocean, published by the German Observatory. Report of Magnetic Observations on German Coast, 1896. Possible Explanation of Mistpoeffern. The Ice Limits between Greenland, Iceland and Spitzbergen.

MILITÄR WOCHENBLATT.

No. 59, JULY 3, 1897. Infantry Tactics and Operations of Combined Weapons, 1896. French Marines at the Manœuvres.

No. 60. Establishment of Temporary Quarantine Stations for Japanese Army on the return from the China-Japan War. The Darmancier Field-piece.

No. 63. New Drill Regulations for Russian Infantry.

Nos. 64 AND 65. French Cavalry Manœuvres, 1896. Judging Distances.

Nos. 68 AND 69. On the Increase of the Fleet. On the Disposition of Artillery in two Firing Lines.

No. 71. Fighting Tactics of French Infantry. Military Bicycling.

No. 72. Military Bicycling. Russian Summer Manœuvres.

No. 73. First Aids on the Fighting Line.

No. 74. French Cavalry Manœuvres. Practice March of Swiss Field Artillery.

No. 75. French Cavalry Manœuvres. Field Artillery Questions in Spain. New French Gun.

The new gun, the invention of Captain Humbert of the Naval Artillery, was tested by the Hotchkiss Company and has been placed at the disposal of the Government. There is no recoil on firing. The powder gases are made to discharge towards the rear. This prevents the visibility by the enemy of the flames of discharge, which at present reveal the position of a battery of artillery using smokeless powder. The report is also deadened so as to be inaudible beyond 1200 meters.

No. 77. Test of Experimental Turret in the United States.

H. G. D.

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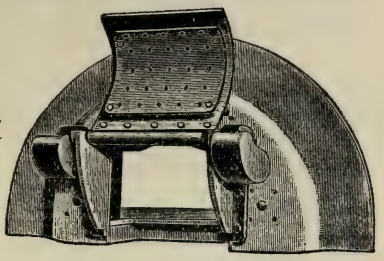

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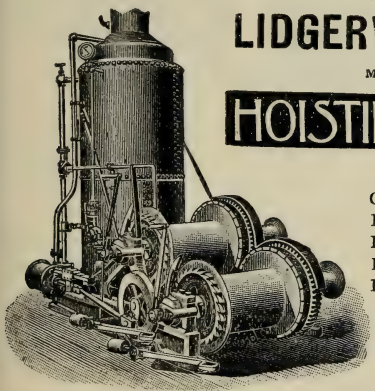

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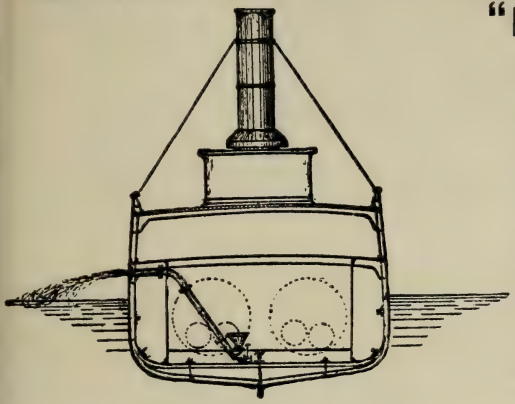

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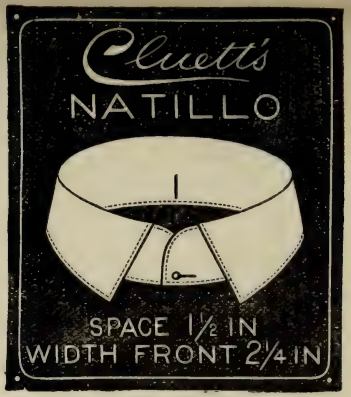

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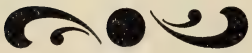

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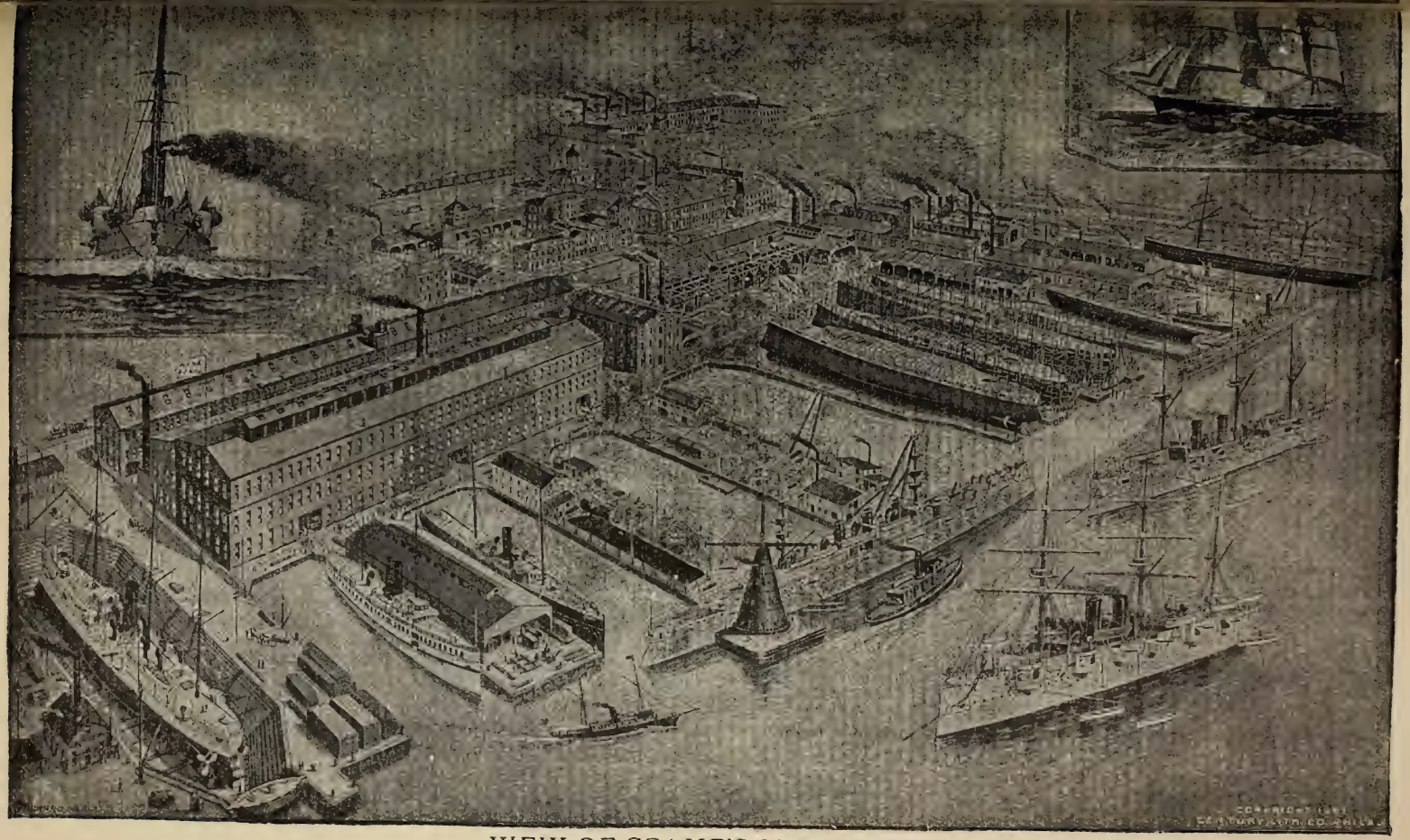

VIEW OF CRAMP'S SHIP YARD.

Vol. XXIII., No. 4. 1897. Whole No. 84.

PROCEEDINGS

OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XXIII.

EDITED BY H. G. DRESEL.

PUBLISHED QUARTERLY BY THE INSTITUTE.

ANNAPOLIS, MD.

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Sec'y and Treas., U. S. Naval Institute.

The Lord Baltimore Press

THE FRIEDENWALD COMPANY

BALTIMORE, MD., U. S. A.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HOMING PIGEONS AS MESSENGERS OF THE FLEET.

By E. W. EBERLE, Lieutenant, U. S. Navy.

The purpose of this paper is to show the practical working of a messenger pigeon service and to point out conditions under which it may be used with much advantage to the fleet.

The question of communication by means of signals arose with the first organization of fleets, as it was realized that a fleet could not render efficient service unless orders could be signaled by the flagship, and thus have all vessels under the control of the central power.

During our present age of large fleets of high-powered vessels, the question of signaling becomes a most serious factor, because it is of the utmost importance for the commander-in-chief to be able to communicate rapidly over long distances in order to concentrate or deploy his vessels as the conditions of war demand.

Many codes of signals have been used, and now we find ourselves in possession of codes that have very limited ranges. By long-distance day signals our limit of communication is between three and four miles, and by night signals about seven miles,

while this range may be increased at night by signaling with the electric search-light.

However, all of our present methods of signaling are limited to distances less than ten miles, distances which can be covered by modern fleets in little more than one-half hour, and from this we realize that a system of long-distance communication becomes the more necessary with the increasing speed of modern war vessels.

In the past, when fleets could make only six or seven knots, their approach could be signaled by our present code in time to permit our vessels to prepare for action; but with vessels of twenty knots speed the result is far different, and we must have long-distance communication in order to enable our fleets to manœuvre for advantageous positions, to form a junction at the point of attack, or to move to intercept the enemy. If, then, we can devise a system by which we can have reliable communication with the shore from any position as far as *one hundred and fifty miles at sea*, we will have solved the all-important problem, and the only way to obtain this long-distance communication over water is by means of messenger pigeons.

It is not necessary to go into the details of the many experiments made with homing pigeons both in Europe and in America, because the experimental stage belongs to the past, and it has been determined beyond question that trained pigeons are *reliable messengers* for long distances over land or water. It is safe to assume that in a well-regulated pigeon service, at least eighty per cent. of all pigeons released within one hundred and fifty miles of their home station can be relied upon to make the flight at a rate of twenty-five to forty miles an hour. Throughout Europe, for many years pigeons have been used successfully as the bearers of messages; and to-day, in this country, many of these birds are being flown by the numerous "homing clubs" with excellent results.

History records the valuable service rendered by homing pigeons during the siege of Paris in the Franco-Prussian war. At that time a number of homing pigeon societies existed in Paris and in the provinces. All of the trained pigeons of Paris were taken into the provinces before the siege, and those from the provinces were taken into Paris; the result was that daily communication was maintained between besieged Paris and the provinces; and not only official messages were sent, but thou-

sands of private messages. Nearly every balloon that left Paris carried out pigeons, which were in turn released with messages from the besieged capital. During the last few years much attention has been given to the training of pigeons by the signal corps of the foremost European powers, and to-day they possess well-organized pigeon services. They are no longer experimenting with the pigeons, but they are putting them to practical use by sending them out each day as the bearers of important despatches. In Germany, France, Austria, Belgium, Spain, Italy and Russia, the organization of pigeon posts for military purposes is very complete; France, Germany, Italy, Russia and Spain maintain pigeon posts for naval purposes, and Great Britain is now turning her attention to this valuable method of communication over sea.

An issue of the London Royal United Service Institution gives a very interesting account of experiments made during the Italian naval manœuvres. It says:

"An experimental service of carrier-pigeons was instituted on board the Sicilia, Savoia and Re Umberto during the naval manœuvres this year, and gave splendid results. The weekly official resumé of news supplied from the information bureau on board the Elba states that the pigeon service, controlled by the telegraph, gave the most satisfactory results under all possible conditions. The principal centres for the pigeon service were the Sicilia for the Green Squadron, under the direction of an army lieutenant, and on the Savoia and Re Umberto, in charge of two non-commissioned officers of the army, assisted by non-commissioned officers of the navy. Four flights were sent off, one from the Sicilia at Maddalena, fifteen hours to Rome; another from the same ship between Capraia and Vado, and two from the Savoia between Elba and Monte Argentario. The pigeons are kept on board in suitable cages, well ventilated, and are put on lower diet than on shore, with a view to greater speed for flight. The females appear to be the best messengers for short distances, being quicker than the stronger male birds; the latter are, however, more reliable for long distances. The sexes are kept apart from each other. Every flight consists of about five pigeons, and they are fed about two hours before being sent off. Bad weather, birds of prey, etc., may cause them to deviate from a direct line, but in good conditions they can make about 77 kilometers (say 48 miles) an hour." [Italia Marinara.]

Great Britain has a pigeon station at Gibraltar for receiving communications from Tangiers, while Spain has pigeon communication with Ceuta and Melilla in Morocco. Great Britain's most important admiralty stations are located on the Scilly Islands off Lands End, and on Sable Island, one hundred and fifty miles east of Halifax. A regular pigeon post is maintained between Sable Island and Halifax, so that messages received at Sable Island from ships cruising in that vicinity would be transferred to other pigeons and sent to Halifax. Islands in the Mediterranean that have no cable communication with the continent maintain a pigeon post, by which messages are carried at the rate of thirty to forty miles an hour. A pigeon post has been proposed between the Farallones Islands, thirty-two miles due west of San Francisco, and the mainland, for the purpose of bringing reports of the weather, reports of vessels in distress, and other important information.

The Chamber of Commerce of San Francisco is very much interested in the development of this service, and is considering the establishment of a system for the use of the merchant marine on the Pacific coast. Pigeons are being taken out by many steamers leaving San Francisco, and the steamship companies are giving every encouragement to this work. An unusual number of steamers have been lost on the California coast within easy pigeon range of San Francisco during the last three months, and much time has been required to get requests to San Francisco for tugs and other assistance. These cases illustrate the importance of having pigeons on board all coasting steamers, as lives and property could have been saved had not so much valuable time been lost in sending for aid. In most of the cases a pigeon could have reached San Francisco in little more than half an hour, while it took many hours to get the report of the disasters and request for assistance to the nearest telegraph station.

I cite the above instances to show that homing pigeons are the trusted messengers of the European commercial, naval, and military worlds.

If, in the absence of the telegraph, pigeons are entrusted with important messages by commercial houses, where, if they consider the carriers unreliable, they can send their messages, without much financial loss, by the less rapid mail steamers, why

cannot we trust the same messengers with our despatches from sea where we have no other means of communication, and where grave disasters may be averted or decided advantage gained if we can send our information to the commander-in-chief at a high rate of speed?

A poorly equipped pigeon service is worse than none at all, for no reliance can be placed in the time of flight of the birds. Consequently, in order to have an efficient and reliable service we must require rigid and systematic training of the birds within definite geographical limits; we must stock our lofts with homers of the best breed; and we must issue instructions to govern the care of these little messengers when confined on board ship, and to define the limits within which they must be flown.

The naval pigeon stations should be located on or near the coast at well fortified points, or at points inaccessible to the enemy's cruisers; and each station should be connected by telegraph with Washington and the various naval stations, and with all military stations and cities on the seaboard. An efficient messenger pigeon service could be obtained by locating stations on the Atlantic coast at or near the following points: Bar Harbor, Portsmouth (N. H.), Chatham (Mass.), Newport, New York, Delaware Bay, Norfolk, Beaufort (N. C.), Port Royal, St. Augustine, Jupiter Inlet, Key West, Tampa, Pensacola, Port Eads and Galveston. On the Pacific coast at Port Townsend or Port Angeles, Astoria, Empire City (Oregon), Cape Mendocino or Eureka, San Francisco, Port Harford, Wilmington (Cal.), and San Diego.

By this system a ship would be within range of a pigeon station from any position along the coast. Some of the above stations have been established recently by the Bureau of Equipment.

A special system should be adopted for the Great Lakes, as they could be completely covered by trained pigeons, and these stations would be of the utmost importance both to the army and to the navy in the event of war with Great Britain. The homers for the lakes could be trained with very little trouble, and they would prove to be of much value to the shipping world in peace times, as they could be flown from any point on the lakes.

Our most important coast stations should be those nearest adjacent foreign territory, for in the event of hostilities with a government having such possessions, our fast cruisers could

scout the enemy's coast, keeping a constant watch on the ports used as a rendezvous for the enemy's fleets, and still be in communication with the home station. Consequently, *Key West* should be our most efficient station on the Atlantic, and Port Townsend on the Pacific; the former being only two hours' flight, and the latter one hour's flight from foreign ports.

Charts (see appended charts) should be made containing the locations and limits of the pigeon stations, so that plotting the ship's position on the chart will show immediately which pigeons are to be flown from that position. It would be well to note each pigeon station on the chart with colored ink and draw the limits of the station with ink of the same color so that they may be seen readily, and so that the overlapping limits of stations will not be confused.

It is very important that the pigeons should be flown only within the limits of their home station, and for efficient and reliable service the limits of a station should contain only about two hundred miles of the coast line, that is, about one hundred miles on either side of the station. The charts prepared to accompany this paper give limits within which very good flights should be obtained, but in case of emergency pigeons should be released from positions far beyond the limits given on the charts.

To avoid confusion and loss of time in the selection of messengers, the pigeon-cote for a ship should be so constructed as to have a small compartment for each station on the coast, and the name of the station with its geographical limits should be stamped in the proper color on the door of its compartment. Each compartment should contain pigeons of the station as stamped on its door, and from no other station.

"First-rate naval powers, more especially those with long stretches of coast line, realize the importance of using vessels as scouts in time of war; fast merchant steamers of large coal capacity being well fitted for such service. A proper organization of such scouting vessels into a scouting division would prove a particularly valuable aid to a fleet of battle-ships and to the military stations along the coast. It may be remarked that a small fleet of battle-ships with an efficient scouting service, by using its information to decide when to strike and when not to strike, can so baffle and worry a superior enemy as to keep him always on the defensive, thus pursuing a Fabian policy adapted to the sea."

The scouts form the "information bureau" of the fleet; they tell when and where to strike the enemy. Deprive the fleet protecting our vast coast line of its scouts and you reduce its usefulness fifty per cent.; it is like depriving a boxer of the protection of his guard arm. The scouts are the guard arm of the fleet; they insure against surprise; they place the fleet on the offensive and enable it to select the most opportune time to strike the "knock-out" blow with its powerful right arm—the battle-ships.

In protecting our coast our strength lies in concentration of forces; our fighting ships are too few in numbers to be divided; we must keep them together in order to be able to strike a powerful, decisive blow, and here is where the scouts, with their swift-winged little messengers, stand out in such importance, because the scouts are the ones that furnish the fleet with the information which tells *when* and *where to strike* with the death-dealing right. A fleet without scouts is like an army without cavalry.

In the event of hostilities between two nations of equal naval strength, the one that has the more efficient scouting division will have the advantage more or less decided in proportion to the superiority of this division.

In order to obtain the best service from scouting vessels, it is necessary that they should have rapid and reliable communication with the shore from various distances at sea, and the only way of accomplishing this is by means of homing pigeons. The nation that has a number of twenty-knot cruisers of large coal capacity, and homing pigeons trained to fly at a speed of thirty to forty miles an hour from various distances off the coast, will have an *ideal scouting division.*

In time of hostilities we would find much difficulty in protecting the cities along our extensive coast line, even if we possessed a naval force as large as that of Great Britain or France. It would not be wise to scatter our battle-ships and armored cruisers along the coast and thus be so weak at every point as to be unable to attack or to withstand an enemy's fleet. Our probable plan would be to concentrate the battle-ships and armored cruisers at two or more strategic points, to station monitors and torpedo-boats at various ports, and to use the fast cruisers and naval reserve steamers for patrol duty and for destroying the

enemy's commerce. The coast line would be divided into sections, and cruisers of the Columbia and Cincinnati type would be used for patroling these sections, thus forming a continuous picket line.

In order that the patrol vessels or scouts may perform efficient service, they must have reliable pigeon communication with the shore, and thus be able to remain on the picket line and send in their messages.

PROBLEM I.—[*See Chart No.* I.]

A large fleet of battle-ships, armored cruisers, and protected cruisers approaching the coast to make an attack on a fortified port, or in search of a hostile fleet, would be steaming, probably, less than twelve knots per hour; consequently, the fast scout, which had been under full steam since sighting the smoke of a large fleet, can easily escape from any pursuing cruisers. Upon being chased, the scout should, if possible, lay a course similar to the apparent course of the enemy's main fleet; so that, when the chase is abandoned, the fleet may again be sighted and more information despatched to the shore station. By keeping a long distance in advance or inshore of a hostile fleet—always, if possible, keeping it in sight, however—a scouting vessel, by despatching pigeons, may be able to keep the shore stations informed of the fleet's movements until it is actually sighted from the land. If one scout should lose sight of the hostile fleet, another would probably pick it up later, and pigeons would carry the news to the shore; thus all the forts and all the ships along the coast could be informed of its approach, and of its general course, speed, and strength.

For the purpose of illustrating the usefulness of the messenger-pigeon service, let us assume: (1) that hostilities exist between the United States and a first-rate naval power of Europe; (2) that the United States has an efficient messenger-pigeon service; (3) that her fast cruisers and the fast steamers of the naval reserve are stationed as scouts along the coast from Cape Sable, Nova Scotia, to Galveston; (4) that the scouts have orders to cruise as far as one hundred miles from the coast and to destroy the enemy's commerce, but if the enemy's fleet is sighted the scouts are to keep in touch with it as long as possible and despatch pigeons with information of its movements, speed and strength;

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BAR HARBOR
NEW BRUNSWICK
NOVA SCOTIA

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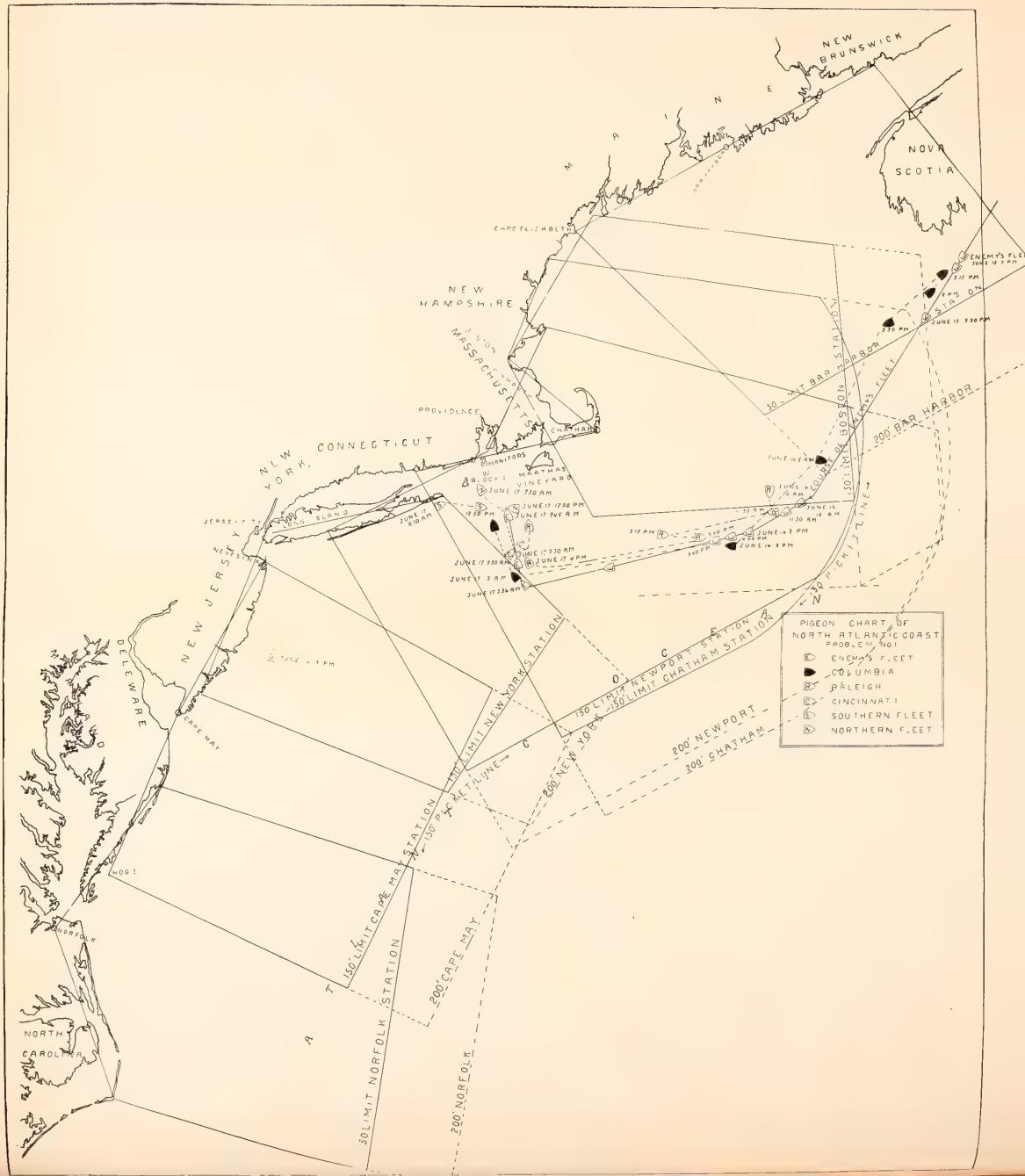
NEW BRUNSWICK
NOVA SCOTIA
MAINE
NEW HAMPSHIRE
MASSACHUSETTS
PROVIDENCE
CONNECTICUT
NEW YORK
NEW JERSEY
DELAWARE
MARYLAND
VIRGINIA
NORTH CAROLINA
CAPE ELIZABETH
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JUNE 17 12 50 PM
JUNE 17 3 36 A M
JUNE 17 5 30 PM
JUNE 17 7 PM
150 LIMIT NEW YORK STATION
150 LIMIT NEWPORT STATION
150 LIMIT CHATHAM STATION
150 LIMIT CAPE MAY STATION
150 LIMIT NORFOLK STATION
50 LIMIT BAR HARBOR STATION
50 LIMIT BOSTON STATION
200 BAR HARBOR
200 NEWPORT
200 CHATHAM
200 CAPE MAY
200 NORFOLK
PIGEON CHART OF NORTH ATLANTIC COAST
PROBLEM NO I
ENEMY'S FLEET
COLUMBIA
RALEIGH
CINCINNATI
SOUTHERN FLEET
NORTHERN FLEET

(5) that the scouts are not to engage the enemy's cruisers sent in pursuit, except as a last resort when hard pressed; (6) that the Columbia is ordered to scout from Cape Sable, Nova Scotia to Browns Bank, the St. Paul from Browns Bank to Georges Shoal, the Raleigh from Georges Shoal to New South Shoal lightship, and the Cincinnati from New South Shoal lightship to Montauk Point; (7) that these vessels are supplied with pigeons from all stations on the New England coast and from the New York station; (8) that the battle-ships and armored cruisers are organized in two fleets—the northern fleet being stationed in the vicinity of Long Island Sound or New York, and the southern fleet at the entrance of Chesapeake Bay—(9) that coast-defense vessels and torpedo-boats are stationed at ports along the coast—three monitors, one ram, and four torpedo-boats at Newport for the protection of the entrance to Long Island Sound, and three monitors and two torpedo-boats at Boston. On June 15, at 6 P. M., the following pigeon message is received at the Bar Harbor station (see Chart No. I):

U. S. S. Columbia,
At sea, Lat. 42° 55′ N., Long. 65° 40′ W. (31′ S. S. W. Cape Sable), 2 P. M., June 15, 1896.

To the Secretary of the Navy:

Have just sighted smoke of a large number of vessels to N'd and E'd of Cape Sable, apparently standing to S'd and W'd. I will try to ascertain nature and course of the vessels.

Commanding Officer.

Upon the receipt of this message, orders are telegraphed to the northern and southern fleets to be ready to sail at a moment's notice, and the message is telegraphed to all naval and military stations on the New England coast.

On June 15, at 7.30 P. M., two pigeons arrived at the Bar Harbor station, each with the following message:

U. S. S. Columbia,
At sea, Lat. 43° 03′ N., Long. 65° 31′ W., 3.15 P. M., June 15, 1896.

To the Secretary of the Navy:

Have just sighted a large fleet—probably twenty vessels—to N'd and E'd of Cape Sable, standing about S. W. by W. (mag.) to S'd of Georges Shoal, at rate of about nine or ten knots. Will try to keep in touch of fleet until dark, if not chased, and will then try to lay a course parallel to that taken by fleet.

Commanding Officer.

Upon the receipt of this message, the northern fleet is ordered to take station off Newport, and the southern fleet is ordered to proceed with all speed to New York. All naval and military stations on the northern coast are informed of the approach of a large fleet.

On June 16, at 9 A. M. and 9.35 A. M., pigeons arrive at the Chatham, Mass., station, each with the following message:

U. S. S. COLUMBIA,
At sea, Lat. 41° 21′ N., Long. 67° 14′ W.,
5 A. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Lost sight of enemy's fleet yesterday at 5.30 P. M., when we were in Lat. 42° 37′ N., Long. 66° 17′ W., having been chased by three cruisers until after dark. Fleet was still steering about S. W. by W. (mag.) to S'd of Georges Shoal, and had been on that course for about three hours. Made out mastheads of eighteen vessels. Have not sighted the fleet this morning, but I hope to pick up smoke very soon.

COMMANDING OFFICER.

The northern fleet is kept in readiness to sail at a moment's notice, in order to intercept the enemy's fleet if it should head for Boston.

On June 16, at 12.45 P. M. and at 1.20 P. M., pigeons arrive at the Chatham, Mass., station, each with the following message:

U. S. S. RALEIGH,
At sea, Lat. 41° 02′ N., Long. 67° 51′ W.,
10 A. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have sighted a large amount of smoke bearing about S. E. by E. (mag.). It is probably smoke of a large number of vessels in company standing to the W'd. I will try to learn something more definite.

COMMANDING OFFICER.

and at 2.25 P. M. the following message is received at the same station:

U. S. S. RALEIGH,
At sea, Lat. 40° 52′ N., Long. 67° 50′ W.,
11.30 A. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have just sighted a large fleet—probably fifteen or twenty vessels—on bearing E. by S. (mag.). Fleet is standing about W. by S. (mag.), to S'd of New South Shoal Lt. Sh., at a speed of eight or nine knots. Two vessels have just been detached from fleet and evidently intend to chase me. I am standing for New South Shoal Light Ship.

COMMANDING OFFICER.

By this message it is seen that the enemy was standing too far to the S'd for an attack on Boston, and was evidently bound for Newport or New York. Consequently, a despatch vessel is sent from New York to intercept the southern fleet and give orders to the commander-in-chief to take station off Montauk Point as soon as possible, in order to intercept the enemy; to station a despatch vessel within signal distance of the Montauk Point signal station for the purpose of receiving orders or information from the commander-in-chief of the northern fleet, and to be ready to move with all speed to the support of the northern fleet.

At 5.30 P. M. and 5.45 P. M., June 16, pigeons arrived at the Chatham station each with the following message:

U. S. S. COLUMBIA,
At sea, Lat. 40° 34′ N., Long. 68° 19′ W.,
3 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have again sighted smoke and mastheads of a fleet bearing E. N. E. ½ E. (mag.), and standing about W. ½ S. (mag.), to S'd of New South Shoal. Speed eight or nine knots. Fleet must contain fifteen or twenty fighting vessels and has steered the same general course since first sighted by us off Cape Sable yesterday at 2 P. M.

COMMANDING OFFICER.

At 5.20 P. M. the following message is received at the same station:

U. S. S. RALEIGH,
At sea, Lat. 40° 40′ N., Long. 69° 10′ W.,
3.15 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

We have lost sight of the enemy's cruisers after having been chased for three and one-half hours, and we will now attempt to find enemy's fleet before dark. My last message was sent at 11.30 A. M. to-day, and stated that a large fleet was sighted bearing E. by S. (mag.), when we were in Lat. 40° 52′ N., Long. 67° 50′ W., and that it was standing on a course about W. by S. (mag.) to the S'd of New South Shoal, at a speed of eight or nine knots.

COMMANDING OFFICER.

and at 7.10 P. M. and 7.30 P. M. the following message in duplicate is received at the same station:

U. S. S. COLUMBIA,
At sea, Lat. 40° 35′ N., Long. 68° 34′ W.,
4.40 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

After sending message at 3 P. M. to-day, I steamed ahead to avoid enemy's cruisers and lost sight of fleet; but later I slowed engines, and

fleet has just been sighted from aloft on bearing E. ½ N. (mag.). Fleet is still steering about W. (mag.) to S'd of New South Shoal Lt. Sh., and making about eight or nine knots. Fleet is large, and had kept same general course since passing Cape Sable.

COMMANDING OFFICER.

and at 7.30 P. M. the following message is received at Chatham:

U. S. S. RALEIGH,
At sea, Lat. 40° 39′ N., Long. 68° 45′ W.,
5.40 P. M., June 16, 1896.

TO THE SECRETARY OF THE NAVY:

Have again picked up enemy's fleet on bearing E. S. E. (mag.), and it is steering about West (mag.), to the S'd of New South Shoal Lt. Sh., making eight or nine knots. Fleet seems to have between fifteen and twenty ships, and has been making course West (mag.) since I sighted them at 11.30 A. M. to-day. I will keep in touch with fleet until dark if permitted to do so by the cruisers. The evident intention is to make an attack on Newport or Long Island Sound at daylight to-morrow.

COMMANDING OFFICER.

The above message is telegraphed to all points on the coast, and full preparations are made to resist the attack. The northern fleet is informed, by despatch vessels, of the enemy's movements; and the Montauk Point signal station is telegraphed to signal the information to the southern fleet upon its arrival.

At 6.35 A. M., June 17, two pigeons arrive at Newport station, each with the following message:

U. S. S. CINCINNATI,
At sea, Lat. 40° 34′ N., Long. 70° 54′ W.,
5 A. M., June 17, 1896.

TO THE COMMANDANT NEWPORT NAVAL STATION:

Have just (daylight) sighted a large fleet on bearing S. by W. ½ W. (mag.). Fleet is standing in for Newport. Cannot make out number of vessels. I will slowly approach the fleet to learn its strength, and I will run for Newport when chased.

COMMANDING OFFICER.

The northern fleet gets under way by daylight from anchorage near Block Island, and at 7.45 A. M., when 8′ S. E. by E. of Block Island, it is signaled by a despatch boat and given the above message from the Cincinnati. The message is telegraphed to Montauk Point for the southern fleet, with orders to cruise off the east end of Long Island, but within easy communication of the Montauk Point signal station.

At about 7 A. M., June 17, messages, in duplicate, are received at the Chatham and Newport stations from the Columbia and Raleigh, stating that the enemy's fleet had passed about 20 miles to the S'd of New South Shoal lightship, and had laid a course for Newport about 4 A. M., steaming about ten knots; and that at daylight the fleet had been sighted in lat. 40° 12′ N., long. 70° 59′ W., heading for Newport, and that the Columbia and Raleigh were making for Newport.

At 7.10 A. M., June 17, three pigeons arrived at the Newport station each with the following message:

U. S. S. Cincinnati,
At sea, Lat. 40° 32′ N., Long. 70° 59′ W.,
5.30 A. M., June 17, 1896.

To the Commandant Newport Naval Station:

Enemy's fleet bears S. ¼ E. (mag.), distant about 7 miles, heading for Newport at speed of about twelve knots. The fleet consists of about twenty-three vessels, and, as well as I can make out, are as follows: six battle-ships, five armored cruisers, eight cruisers, and four large torpedo-boats. The present formation is double column, battle-ships leading, with torpedo-boats between main columns. I am making for Newport under full speed, being chased by two cruisers. I have not yet sighted our fleet, but have just sighted a vessel to E'd, off starboard quarter, and it is probably Raleigh making for Newport, as enemy has just sent a cruiser after her. Enemy has just sent torpedo cruisers ahead as scouts.

Commanding Officer.

This message is telegraphed to the Montauk Point signal station for the southern fleet, and is immediately sent to the northern fleet by a twenty-knot despatch vessel; and the fleet is signaled at 8.30 A. M., 15 miles S. E. ½ E. (mag.) of Block Island, just after it has made out the Cincinnati and Raleigh, and has sighted a large amount of smoke to the S'd.

At 7.40 A. M., pigeons arrive from the Raleigh with messages of same general purport as the message from the Cincinnati.

At 8.20 A. M., June 17, three pigeons arrive at the Newport station, each with the following message from the flagship of the northern fleet:

U. S. Flagship Kearsarge,
8′ S. E. by E. (mag.) of Block Island,
7.50 A. M., June 17, 1896.

To the Commandant Newport Naval Station:

Have just received Cincinnati's message dated five o'clock this morning. Will endeavor to engage the enemy about 26 miles S. by E. (mag.)

of Pt. Judith. Send the three monitors, the ram, and torpedo-boats with all speed to join me at that point. Sea smooth, very favorable for monitors and torpedo-boats. Telegraph Montauk Point Signal Station to signal Southern Fleet to join me with all speed at a point 26′ S. by E. (mag.) of Pt. Judith; also send a despatch vessel to communicate with southern fleet off Montauk Pt. Have just sighted two vessels. One is probably Cincinnati. She will remain with the Flag.

COMMANDER-IN-CHIEF.

At 10.35 A. M., June 17, two pigeons arrived at the Newport station, each with the following message:

U. S. FLAGSHIP KEARSARGE,
24′ S. by E. ¼ E. (mag.) of Pt. Judith,
9.45 A. M., June 17, 1896.

TO THE COMMANDANT NEWPORT NAVAL STATION:

Have just engaged enemy at long range. Torpedo-boats are just arriving and monitors are in sight. Enemy's fleet is composed of seven battle-ships, six armored cruisers, six cruisers, and four torpedo-boats. Telegraph Southern Fleet at Montauk Pt. Signal Station to join me with all speed at this point, if you have not already done so. Telegraph Boston to send monitors with all speed to take station to the E'd of Phelps Bank, in order to cut off retreat of enemy.

COMMANDER-IN-CHIEF.

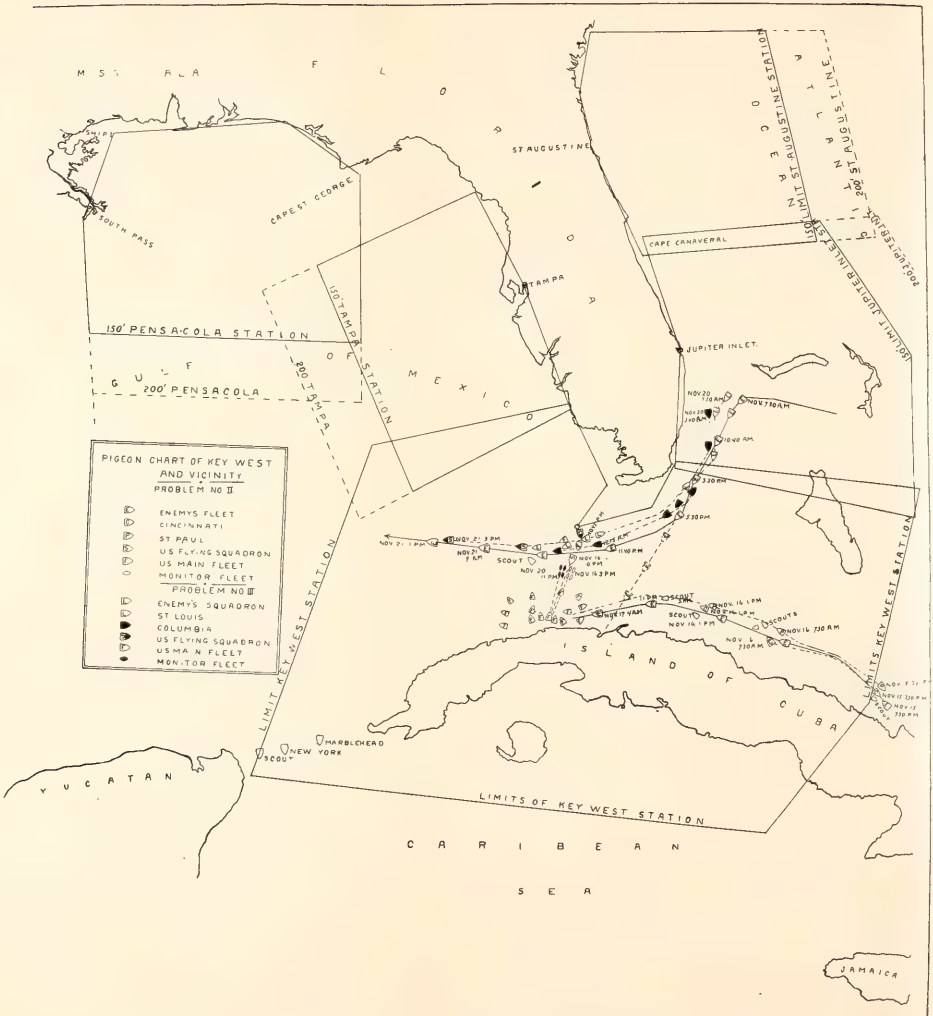
At 1.35 P. M., June 17, the following message in duplicate is received at Newport:

U. S. FLAGSHIP KEARSARGE,
26′ S. S. E. (mag.) off Point Judith,
12.50 P. M., June 17, 1896.

TO THE COMMANDANT NEWPORT NAVAL STATION:

Have closed to 1600 yards, both sides suffering severely. Enemy's losses are: two cruisers and one torpedo-boat sunk, two armored cruisers set afire and disabled, and two battle-ships partially disabled—unable to fire barbette guns. Have just ordered Cincinnati, San Francisco, and Montgomery to attempt to make the Sound. They are disabled and leaking badly, so send tug to meet them between this point and the Sound, and tow them to New York with all speed. Telegraph New York Navy Yard to have docks ready to receive disabled cruisers. Monitors are doing effective work. Southern Fleet has been sighted. Brooklyn has signaled that she is seriously damaged and unmanageable. Have signaled Detroit to tow Brooklyn beyond the line of fire and try to make Newport. Send some vessels to her assistance. Take her to New York if possible, and only beach her as the last resort. Have lost one torpedo-boat.

COMMANDER-IN-CHIEF.


PIGEON CHART OF KEY WEST AND VICINITY
PROBLEM NO II
ENEMYS FLEET
CINCINNATI
ST PAUL
US FLYING SQUADRON
US MAIN FLEET
MONITOR FLEET
PROBLEM NO III
ENEMY'S SQUADRON
ST LOUIS
COLUMBIA
US FLYING SQUADRON
USMAN FLEET
MONITOR FLEET
MISS ALA
FLORIDA
GULF OF MEXICO
CAPE ST GEORGE
SOUTH PASS
150' PENSACOLA STATION
200' PENSACOLA
150' TAMPA STATION
200' TAMPA
LIMIT KEY WEST STATION
ST AUGUSTINE
CAPE CANAVERAL
TAMPA
JUPITER INLET
150' ST AUGUSTINE STATION
200' ST AUGUSTINE
LIMIT JUPITER INLET STATION
200' JUPITER INLET
LIMITS KEY WEST STATION
ISLAND OF CUBA
MARBLEHEAD
NEW YORK
SCOUT
YUCATAN
LIMITS OF KEY WEST STATION
CARIBBEAN SEA
JAMAICA

PROBLEM II.—[*See Chart No. II., Gulf of Mexico.*]

Let us assume that strained relations have existed between the United States and Spain for several weeks and that both nations are preparing for war. Spain has continually increased her fleet in Cuban waters until it consists of the following-named vessels: The 9900-ton battle-ship Pelayo; the 7000-ton armored cruisers Infanta Maria Theresa, Viscaya, Princessa de Asturias and Cataluna; the 3300-ton cruisers Alfonso XII., Aragon, Navarra and Castella; the 1100-ton cruiser Conde de Venadito, and six others of the same class; eight gunboats of about 750 tons, and six torpedo-gunboats.

Havana is the headquarters of this large fleet, while the cruisers and gunboats patrol the coast for filibustering expeditions.

The United States has gradually recalled vessels from foreign stations and assembled at Key West a powerful fleet, which now comprises most of the ships of the navy and many armed steamers of the reserve. An efficient messenger-pigeon service is in operation with stations at Key West, Tampa and Pensacola on the west coast of Florida, and at Jupiter Inlet and St. Augustine on the east coast. Particular attention has been given to the training of the pigeons of the Key West station, as this station contains within its range the Old Bahama Channel, the Straits of Florida and Yucatan Channel—the three channels leading to Havana—as well as the coast of Cuba east and west of Havana. (See charts Nos. II. and III. for limits of stations.)

The commander-in-chief of our fleet has organized a scouting division of high-speed vessels, and each vessel is to carry pigeons from all Florida stations.

In the event of hostilities, the scouts are to take station and cruise in pairs as follows (see chart): The Cincinnati and N. R. S. S. St. Paul off Cay Frances, to patrol the west entrance to Old Bahama Channel; the Marblehead and N. R. S. S. New York off Cape San Antonio, to patrol Yucatan Channel; the Columbia and N. R. S. S. St. Louis between Florida coast and Great Isaac, at the junction of Florida Strait and N. W. Providence Channel, to patrol the north entrance to Florida Straits, and the Raleigh and N. R. S. S. Paris to patrol the Cuban coast near Havana. Other vessels of the naval reserve are to cruise

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within the limits of the various pigeon stations on the Gulf and Atlantic coasts.

The principal duty of the scouts is to watch the movements of the enemy's ships and to report by messenger pigeons what information is obtained; the secondary duty is to capture the enemy's and contraband neutral commerce within the limits of their scouting stations, but not to engage the enemy's war vessels except under very favorable conditions.

In his orders to the scouting division, the commander-in-chief states that scouts are not fighting ships, and that the object in using them is not for the purpose of engaging the enemy's vessels single-handed, but for the purpose of keeping the commander-in chief informed of the general movements of the enemy's vessels, thus enabling him to surprise and strike the enemy with his heavy fighting ships.

On September 10 our minister is withdrawn from the Court of Spain, our consular officers leave the Spanish ports, and a state of hostilities is declared to exist with the government of Spain. Upon the withdrawal of our Consul-General from Havana, he reports the presence in that port of the entire Spanish fleet, as referred to above, except a few gunboats that are still along the Cuban coast; and he further reports extensive preparations on shore and afloat to defend the port of Havana. New guns have been mounted in the fortress, and the fleet is to assist in the common defense of the port.

In its manifesto notifying foreign governments of the existence of a state of hostilities, the United States Government grants many concessions to neutral trade; and at the same time orders are issued to the commander-in-chief of our naval force directing him to refrain from bombarding even fortified ports where the lives and property of non-combatants are endangered. Resort must be had to blockading the enemy's ports and to attacking his fleet upon the sea.

Our ships are organized into three divisions—the "main fleet," the "flying squadron," and the "scouting squadron." The main fleet is composed of the following-named vessels: Iowa (flag), Indiana, Massachusetts, Oregon, Texas, Puritan, Terror, Amphitrite, Miantonomoh, Monterey, Philadelphia, Boston, Atlanta, Montgomery, Detroit, Charleston, Concord, Yorktown, Bennington, Machias, Castine, Katahdin, Vesuvius, eight torpedo-boats, and four despatch vessels.

The "flying squadron" is composed of the Brooklyn (flag), New York, Olympia, Maine, Baltimore, Chicago, Minneapolis, San Francisco, Newark, and four fast steamers or yachts for despatch duty.

The scouting vessels are sent to their stations, as above detailed, while the main fleet and the flying squadron remain at Key West.

By stationing the scouting vessels in the three channels leading to Havana, the commander-in-chief is insured of the receipt of information, by pigeon messages, of the approach of the enemy's vessels within four or five hours after they are sighted by the scout.

The scouts off Havana can send pigeon messages to the commander-in-chief in two hours' time, thus informing him of any movements of the main Spanish fleet at Havana.

With this disposition of scouting vessels, which vessels can communicate with Key West by messenger pigeon within less than five hours, the commander-in-chief becomes master of the situation, and he can intercept any movement of the enemy. Knowing the names of the Spanish vessels in Cuban waters at the beginning of hostilities, the commander-in-chief knows the remaining ships of the Spanish Navy that are available for an attempt to re-enforce the fleet at Havana, or for making a descent on our coast cities. The only vessels available for the service are the Carlos V. (cr. 7000 tons), Almirante Oquendo (ar cr. 7000 tons), Alfonso XIII. (cr. 5000 tons), Lepanto (cr. 4800 tons), Reina Christina (cr. 3500 tons), Reina Mercedes (cr. 3100 tons), and a few old vessels of low speed.

The "flying squadron" has been organized of vessels that are capable of overtaking and defeating a fleet composed of the above-named Spanish vessels. This squadron is to remain at Key West and await pigeon messages from its scouts telling of the approach of any Spanish re-enforcements, and then it is to manœuvre to intercept and capture the re-enforcing fleet. If Spanish vessels should approach to attack our coast cities, the news of the approach would probably be received at the proper pigeon station from the scouts stationed along the coast and then telegraphed to Key West; this would cause the "flying squadron" to move up the coast (communicating with pigeon stations along the coast by despatch vessels as it proceeds) for the purpose of finding and engaging the enemy.

On account of the humane and highly commendable course assumed by our Government, the commander-in-chief is debarred from bombarding the port of Havana and thus sacrificing innocent life and property. Consequently, his object is to remain at Key West and endeavor to entice the Spanish fleet out of Havana; and as any movement of the enemy's fleet will be reported at Key West by pigeons within two hours, the commander-in-chief will be able to chase and engage the enemy, or at least the flying squadron will be able to overtake and engage the enemy until the arrival of the main fleet. The "flying squadron" appears off Havana for the purpose of inducing the enemy to come out and engage a smaller fleet, but without success.

The scouts in the three channels have practically stopped all commerce with Havana. The scouts off Havana send daily messages to Key West, stating that the Spanish fleet remains in the harbor, thus showing that the Spanish commander-in-chief is not desirous of engaging our fleet, but knowing our superior strength, he wisely prefers to assist the forts in the defense of Havana.

All efforts to draw the Spanish fleet out of Havana proving futile, a strict blockade of Havana is ordered, and the main fleet, with the exception of the monitors, sails for Havana and establishes the blockade. The flagship is supplied with Key West pigeons, to be used in communicating with the "flying squadron," the monitors and the colliers and supply vessels at Key West. Despatch vessels from Key West supply the flagship with pigeons every few days.

Ten days after the establishment of the blockade, news is received in Washington from Madeira of the arrival at the latter place of a steamer reporting "having sighted a Spanish fleet to the W'd of Madeira and standing W.S.W." Fifteen days later a British steamer arrives at Baltimore from Barbadoes and reports having been stopped and searched, five days before when off the Virgin Islands, by the Spanish cruiser Almirante Oquendo, the flagship of a squadron of six large vessels and four torpedo-gunboats, and that the squadron laid a course for Porto Rico after the search.

This news is telegraphed to Key West and it is concluded that the "Spanish relief squadron" has stopped at Porto Rico for coal and to communicate with Havana.

Two additional scouts are immediately sent out to find the St. Paul and Cincinnati in Old Bahama Channel, and, in company, they are to patrol the eastern entrance to Old Bahama Channel. When the scouts sight the Spanish squadron they are to despatch pigeons, and one vessel is to proceed with all speed to communicate with the commander-in-chief off Havana, despatching pigeons to Key West frequently when within easy range; the other scouts are to keep in touch with the enemy and despatch pigeons with information of his movements.

We now have a very interesting but simple problem: We have the main Spanish fleet blockaded in Havana by a much superior American fleet; we have our "flying squadron" at Key West ready to move in any direction at a high rate of speed; we have the three passages to Havana and to the Gulf of Mexico patrolled by scouts that can get pigeon messages to Key West within four or five hours; we have at Key West a fleet of monitors which, after a Spanish relief squadron arrives within easy pigeon range, can join our main fleet off Havana long before the Spanish squadron can possibly reach Havana; and we have the news of the presence of a Spanish "relief squadron" of six vessels in the neighborhood of Porto Rico.

Let us assume that the object of the Spanish commander-in-chief is to effect an escape from Havana with his fleet, and that his plan is for the "relief squadron" to attempt to raise the blockade of Havana by appearing off that port for a combined attack on our main fleet, or for the "relief squadron" to attempt to draw our fleet from Havana by making an attack on one of our ports. The Spanish squadron being in possession of no coaling port nearer our coast than Porto Rico, will probably not make a raid on the ports of our northern coast, which are so far from the base of supplies.

We now arrive at the point in our problem where the messenger pigeons become of great importance, and by using them our problem becomes very simple (see "scouts" on chart). We practically have the main Spanish fleet shut up in Havana, and we will receive notice of the approach of a "relief squadron" from any direction at least ten hours before it can reach Havana by the shortest route; or, in other words, we will receive notice at Key West before such a squadron arrives at any point within 120 miles of Havana, even if it attempts the passage of Old Bahama Channel by night.

If the plan of the Spanish commander is to make a combined attack on our blockading fleet off Havana, the "relief squadron" must reach Havana by one of three routes—by the direct route through Old Bahama Channel, by the indirect route along the south coast of Cuba and through the Yucatan Channel, or by the other indirect route outside of the Bahamas and then through N. W. Providence Channel and Florida Strait.

Let us assume that the Spanish commanders at Havana and Porto Rico have communicated with each other and agreed upon a plan of attack on our blockading fleet. The "relief squadron" is to proceed to Havana by the direct route through Old Bahama Channel, and the attack is to be at daylight on November 17.

Just before dark on November 15, the Cincinnati and St. Paul sight a large amount of smoke to the E'd of Old Bahama Channel. They steam towards the smoke and discover a number of vessels in company standing to the W'd for Old Bahama Channel (see chart No. II.). The Cincinnati and St. Paul steam to the W'd during the night, keeping well in advance of the other vessels, but before daylight they slow down to await the enemy, and at daylight they discover a fleet of warships. The scouts release pigeons from the 200-mile range and steam to the W'd, sighting the fleet at intervals, and finally being joined by the other two scouts at the west entrance to Old Bahama Channel.

At 1 P. M., November 16, two pigeons arrive at Key West from the Cincinnati, each with the following message:

U. S. S. CINCINNATI,
At sea, west entrance Old Bahama Channel,
Lat. 20° 53′ N., Long. 79° 00′ W.,
7.30 A. M., Nov. 16.

Yesterday, at 7.30 P. M., sighted a number of vessels in company standing to the W'd through Old Bahama Channel at a speed of about nine knots. We stood to W'd during night, and early this morning we awaited the vessels and find them to be a fleet of six large vessels and four gunboats standing to the W'd along Cuban coast. We are steaming to the W'd, St. Paul and other scouts appear to be doing the same.

COMMANDING OFFICER.

Upon the receipt of this message the monitors prepare to proceed to Havana, and the "flying squadron" is ready to sail. A despatch vessel is sent with all speed to convey the above mes-

sage to the commander-in-chief off Havana, and to inform him that the monitors and torpedo-boats will be sent to join him.

Soon after the receipt of the above message, similar ones are received from the St. Paul and other scouts.

At 3 P. M. the monitors and torpedo-boats leave Key West to join the main fleet off Havana. The "flying squadron" remains at Key West for further information, in order to see if the enemy continues through Nicholas Channel for Havana, or if he stands to the N'd through Santaren Channel to make a feint at attacking our ports for the purpose of drawing off our blockading fleet.

At 5.30 P. M., several pigeons arrive with messages similar to the following:

U. S. S. St. Paul,
At sea, Nicholas Channel,
Lat. 23° 20′ N., Long. 79° 48′ W.,
1 P. M., Nov. 16.

A fleet of six large and four small vessels has entered Nicholas Channel and is standing to the W'd at speed of about nine knots—evidently intends making an attack on blockading fleet at daylight to-morrow. Cannot make out class of vessels. One scout has been sent to communicate with the commander-in-chief off Havana. These vessels were first sighted last evening at east entrance to Old Bahama Channel and have been standing along Cuban coast. We are in company with Cincinnati and will endeavor to keep in touch with the enemy until dark and during the night; after he passes out of west entrance to Nicholas Channel we will run for Havana to communicate with commander-in-chief.

Commanding Officer.

Messages similar to the above are received at Key West until 8 P. M. from the Cincinnati and St. Paul, and they show that the enemy is bound for Havana.

Before the enemy's "relief squadron" left Porto Rico its commander was informed by the Havana officials of the presence of our monitors at Key West; consequently the Spanish commander has no intention of attacking Key West, which he supposes is still defended by the monitor fleet, but his plan is to make a daylight attack on our blockading fleet before the monitors can re-enforce it.

This plan is effectively thwarted by the receipt of the pigeon messages announcing the approach of the "relief squadron," when it is yet 150 miles from Havana, and thus the monitors and torpedo-boats are given ample time to join the blockading

fleet off Havana long before the enemy's "relief squadron" can possibly arrive there. The "flying squadron" remains at Key West until dark to receive the last pigeon messages, in order to be assured that the Spanish squadron does not diverge from its course for Havana to make a feint at one of our ports. Being assured of the plan of the enemy's squadron, our "flying squadron" sails for Havana with all speed and joins the blockading fleet during the night. At daylight of November 17, when the enemy plans to surprise and overwhelm our blockading fleet by a combined attack during the absence of our monitors, flying squadron and torpedo-boats, he is himself much surprised to find our entire naval force in readiness to receive the attack. These manœuvres to concentrate our forces so quickly in order to receive the attack have been brought about by the receipt of the pigeon messages announcing the approach of the enemy's "relief squadron," and everything hinges on the receipt of this information. In the above problem, the assumption of daylight as the time for the attack gives the most unfavorable conditions for using the pigeon service. If the attack had been planned for a later hour, or in the afternoon, or at night, the pigeons could have kept up continual communication with the home station until the time of the attack.

This problem illustrates how the messenger-pigeon service makes the "flying squadron" the master of the situation, by furnishing such information as to enable that squadron to combine with the main fleet at the proper moment, or to tell it when and where to strike the enemy.

Problem III. [*See Chart No. II.*]

Let us assume now that the Spanish "relief squadron" takes one of the indirect routes to relieve Havana, in order to avoid the scouts that are known to be stationed in Old Bahama Channel. We will see, by a glance at the chart, that information of the approach of the enemy's squadron will be received many hours before it can reach Havana; and, if it is so desired, our flying squadron can easily intercept and engage the enemy's squadron when it is many miles from Havana. If the enemy's squadron comes through the N. W. Providence Channel and Florida Strait, its approach is communicated to the Jupiter Inlet station by pigeons from the Columbia and St. Louis, and is then telegraphed to Key West.

In the morning of November 16, pigeon messages are received at the Jupiter Inlet station from the Columbia and St. Louis, stating that a number of vessels have been sighted; and later on messages state that the enemy's squadron has been sighted entering Florida Strait from N. W. Providence Channel, and standing to the southward. This information is telegraphed to Key West, and a despatch vessel sent to the blockading fleet, as are other messages that arrive later. The monitors and torpedo-boats may be sent to join the fleet off Havana. The "flying squadron" is in position to intercept and attack the enemy's squadron, or it may wait until assured, by the course and position of the enemy's squadron, that Key West is safe and that the plan is to attack the blockading fleet, and then proceed at full speed to join our blockading fleet. By this means the main Spanish fleet may be drawn out of Havana to join the "relief squadron" and then forced to give battle.

If the enemy's squadron attempts to reach Havana by way of Yucatan Channel, its approach will be detected by the Marblehead and New York, stationed in that channel, and the pigeons will arrive in time for the monitors and "flying squadron" to reach Havana long before the attack.

In the above cases the scouts keep in touch with the enemy and despatch pigeons until the destination of the enemy is determined.

We have considered the only three routes by which the enemy's "relief squadron" can reach Havana, and we see how completely it is in the power of the force at Key West, on account of its movements being detected and so quickly reported to Key West.

Next, we must consider the attempt of the enemy's "relief squadron" to make an attack on one of our coast cities for the purpose of drawing our blockading fleet from Havana, and thus permitting his main fleet to escape.

The enemy having his base of supplies at Porto Rico, will attack probably one of our gulf ports, or possibly St. Augustine or Charleston—his only object being to draw away our blockading fleet.

If the enemy enters the Gulf of Mexico, his presence will be known at Key West in time for the "flying squadron" to overtake him before he can reach any gulf port. (See chart No. II). Assume that the enemy's squadron at Porto Rico plans a feint

attack on Pensacola, and, being aware of the presence of our scouts in the Old Bahama Channel, Yucatan Channel, and around Key West, decides to enter the Gulf of Mexico through Straits of Florida and to pass Key West at night. At 9.30 A. M., November 20 two pigeons arrive at the Jupiter Inlet station, each with the following message:

U. S. S. St. Louis,
At sea, Lat. 26° 14′ N., Long. 79° 24′ W.,
7.30 A. M., Nov. 20.

Have just sighted, on bearing E. ½ S. (mag.), a fleet of vessels entering Florida Straits from N. W. Providence Channel and standing to the S'd. I will try to learn strength and nationality of fleet, and will then run to the S'd, keeping in sight of the fleet as long as permitted to do so. Columbia is to S'd and W'd, but not in sight.

Commanding Officer.

This message is telegraphed to Key West, and the monitors, torpedo-boats, and "flying squadron" prepare to sail. A despatch vessel is sent with the message to Havana, and additional scouts are sent to the E'd of Key West with a radius of 20 miles.

At 10.45 A. M., November 20, the following message from the Columbia is received at Jupiter Inlet station:

U. S. S. Columbia,
At sea, Florida Sts., Lat. 26° 01′ N., Long. 79° 42′ W.,
8.50 A. M., Nov. 20.

Sighted the St. Louis about 8.30 this A. M., standing for us at full speed, being chased by an enemy's cruiser. When we joined company, enemy's cruiser hauled off and stood about E. by N. (mag.), in which direction we sighted a large amount of smoke. St. Louis reports having sighted a fleet at 7.30 this morning when in Lat. 26° 14′ N., Long. 79° 24′ W., bearing E. ½ S. (mag.) and standing to the S'd in Florida Straits, and that a vessel was sent in chase of her when she approached to learn strength of fleet. She reports fleet consisting of six or more vessels. We will remain in company and try to keep in touch with the enemy.

Commanding Officer.

A message similar to the above was received at the Jupiter Inlet station from the St. Louis an hour later, and these messages were telegraphed to Key West as soon as received. At 1.45 P. M., November 20, the following message is received at the Jupiter Inlet station from the Columbia, with a similar one from the St. Louis:

U. S. S. Columbia,
At sea, Florida Sts., Lat. 25° 32′ N., Long. 79° 44′ W.,
11 A. M., Nov. 20.

In company with St. Louis, picked up enemy's fleet of about six vessels at 10.40 this A. M., and are now being chased by enemy's cruisers. We are running to S'd at full speed and when chase is abandoned we will try to pick up the fleet. Enemy's fleet is standing to S'd through Florida Str. at speed of about 10 knots.

Commanding Officer.

These messages are despatched to the commander-in-chief off Havana. The vessels at Key West are ready to move at a moment's notice, but await more definite despatches in order to decide upon the probable plan of the enemy.

A message is received at the Key West station about 5.30 P. M., November 20, from the Columbia, dated Lat. 24° 48′ N., Long. 80° 15′ W., 1.45 P. M., November 20, stating that after three hours the enemy's cruisers had abandoned the chase of the St. Louis and Columbia, and had stood to the E'd at reduced speed. The message also states that the St. Louis and Columbia will try to pick up enemy's fleet before dark, and it gives the course, speed and strength of fleet when last sighted. At 6.45 P. M., November 20, two pigeons arrived at the Key West station, each with the following message:

U. S. S. Columbia,
At sea, Florida Str., Lat. 24° 57′ N., Long. 80° 03′ W.,
3.30 P. M., Nov. 20.

We have again sighted enemy's fleet standing about S. W. by S. (mag.) for Matanzas on Cuban coast, at speed of about 10 knots. Fleet consists of about six vessels and entered Florida Str. at 7.30 this morning from N. W. Providence Chl. St. Louis is with us, and we will try to keep in touch of fleet, unless again chased. If during night we find enemy changes his plan, will send St. Louis to Key West and I will run for blockading squadron with the information.

Commanding Officer.

Messages similar to the above are received from the St. Louis, and the monitors and torpedo-boats are ordered to join the commander-in-chief off Havana, as the probable plan of the enemy is to make Matanzas during the night, communicate with Havana by telegraph, and then make a combined attack on the blockading fleet at daylight. Despatch vessels are also sent to inform commander-in-chief. The " flying squadron " is to cruise

off Key West, but remains in port until dark to see if other messages arrive. The "flying squadron" has orders not to leave Key West undefended while the enemy is in that neighborhood, and, at the same time, not to prevent the enemy from attacking the blockading fleet, as the object is to bring on a general engagement and thus draw the enemy's main fleet out of Havana; but the flying squadron is to join the main fleet after the attack is begun, and thus take the enemy in the rear.

At 7.50 P. M., November 20, three pigeons arrive at the Key West station, each with the following message:

U. S. S. COLUMBIA,
At sea, Florida Str., Lat. 24° 43′ N., Long. 80° 17′ W.,
Nov. 20, 5.30 P. M.

Have again picked up enemy's fleet, bearing E. (mag.). Fleet has changed course to the W'd and is now standing about W. S. W. (mag.) at 10 knots speed. Six vessels in fleet. Fleet was standing for Matanzas on Cuban coast when sighted before at 3.30 P. M., had to steam ahead to avoid enemy's cruisers. Probably night attack on Havana intended. Will try to pick up fleet during night, and will then despatch St. Louis with information. Send other scouts to the E'd of Key West to communicate with me during the night, as I must keep in touch of enemy.

COMMANDING OFFICER.

Several pigeons arrive from the St. Louis just about dark with messages similar to the above.

From the above messages, the plan of the enemy cannot be definitely determined; he may be bound for Havana or for Key West or Gulf ports. However, it is readily seen that the enemy cannot reach the neighborhood of Key West before 11.30 P. M. if steaming at 15 knots an hour. Additional scouts are sent out to cruise within 20 miles of Key West. The flying squadron gets under way and takes station off Key West, for the protection of that port, or to intercept the enemy if bound to a Gulf port. The blockading fleet has been re-enforced by the monitors and torpedo-boats, and the flying squadron is in position to move in any direction. At 10.45 P. M., November 20, the St. Louis signals the flying squadron off Key West and reports having been ordered to Key West by the Columbia to report approach of enemy's fleet. At 6.00 P. M. enemy was in lat. 24° 40′ N., long. 80° 18′ W., and standing about W. S. W. (mag.) at 10 knots speed. After a full report of the movement of the enemy's fleet during the day, the St. Louis is sent to scout to the E'd of Key West.

At 1.45 A. M., November 21, a scout signals flying squadron off Key West, and reports having spoken Columbia at 12.15 A. M. when 22 miles E. S. E. (mag.) of Sand Key, and having been ordered to report the enemy's fleet about 15 miles S. E. (mag.) of American Shoal at 11.40 P. M., November 20, and standing about W. S. W. (mag.) at 12 knots speed. Columbia would try to keep with enemy.

At 3.15 A. M., November 21, the St. Louis signals flying squadron that she has failed to find the enemy, and then she is sent to the W'd at full speed with other scouts to try to find the enemy. At 6.00 A. M., November 21, four pigeons arrive at the Key West station, each with the following message from the St. Louis:

U. S. S. St. Louis,
At sea, Lat. 24° 17′ N., Long. 82° 22′ W.,
4.50 A. M., Nov. 21.

At early daylight sighted large amount of smoke to the S'd, and have just made out a fleet on bearing S. E. by S. (mag.), standing about W. (mag.).

Commanding Officer.

Other pigeons arrive from the Columbia with messages stating that at daylight she picked up the fleet standing to the W'd.

Upon the receipt of these messages it is seen that the enemy's plan is to attack a Gulf port and not to attack the blockading fleet. Consequently the "flying squadron" sails at full speed to the W'd and overtakes and engages the enemy before he reaches the nearest Gulf port. This manœuvre to overtake and engage the enemy is made possible only by the receipt of the pigeon messages from the scouts that have kept the "flying squadron" posted of the enemy's movements. If the enemy's plan is to go to Havana direct, or to make Matanzas at night, and after communicating with Havana, to attack the blockading fleet, then the scouts will continue to report the enemy's course until dark. During the night, if the definite plan of the enemy is learned, the St. Louis or other scouts will be despatched to Key West with the information and the Columbia will run for the blockading fleet.

The patrol vessels of the blockading fleet will also report the approach of the enemy, so that pigeons can be despatched at daylight for Key West ordering the "flying squadron" to Havana with all speed, and this squadron will arrive in time to

flank the enemy or to prevent his escape. Fleets at sea beyond communication from the shore are of very little value for concerted action, and therefore it is important to keep the "flying squadron" in port until the definite plan of the enemy is determined, and then to move at high speed in order to strike at the most opportune time and place. As was said before, a squadron of fast ships stationed at Key West, with an efficient scouting division to keep it informed by pigeon post of the movements of the enemy through the three passages to the Gulf, is practically master of the waters of the Gulf of Mexico, and can lay its plans accordingly.

From its geographical surroundings, Key West will become our most important pigeon station on the Atlantic; and Port Townsend, which controls the Strait of Fuca, and entrance to Puget Sound, will be the most important on the Pacific. By glancing at a chart it will be seen that the Port Townsend Station can control the entire entrance to the Western possessions of Great Britain, and this would prove of great value in the event of hostilities with that country.

The rapid concentration of naval forces at the point of attack, or the movement of forces to intercept the enemy, is only made possible when we have a system by which we can communicate rapidly with the shore stations from long distances at sea, and the messenger-pigeon service is the only system by which we can obtain such communication. This service might be called, very appropriately, a "sea telegraph" system, and although its messages cannot be despatched with the speed and absolute certainty of the telegraph, yet the system has the advantage of forwarding its messages from any position within definite limits, and therefore it is not necessary to seek the telegraph station in order to send a message.

In the event of hostilities, many more messages than those given in the above illustrations would be sent, in order to insure the receipt of important information, and if only one of the many little messengers should arrive in time to enable our fleet to manœuvre so as to engage the enemy before he could inflict appalling destruction of life and property upon some one of our seaports, then this service would prove itself most valuable to the Government, and well worth the small annual sum required to maintain its efficiency.

It requires but one practical illustration to strike home and to open our eyes to the merits of this service. Let a single human life be saved from shipwreck in time of peace, or let one manœuvre of the enemy's fleet be frustrated in the midst of war by the timely arrival of one of these swift-winged, trusty little carriers with its urgent message, and all the country will applaud the result and will realize the value of a Messenger-Pigeon Service upon the seas.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PYRO-COLLODION SMOKELESS POWDER.

By Professor D. Mendeléef.

(Translated from the Russian by Lieutenant John B. Bernadou, U. S. Navy.)

The very favorable results obtained with pyro-collodion and its adaptability to arms of all calibers depend upon its composition and properties, which, for purposes of illustration, may be compared with those of other materials employed as smokeless powders.

As to its chemical composition, pyro-collodion may be designated *homogeneous*,* and herein consists one of its most important qualities. All previous and present forms of powder did not have or do not have this property to the degree here implied. From their very method of preparation, black and brown powders are coarse mechanical mixtures, for which any consideration of homogeneity is out of the question. The same is true for those smokeless powders containing ammonium nitrate, picrates, etc. Nitro-glycerine powders may be regarded as gelatinous solutions of nitro-cellulose in nitro-glycerine, which, from their composition, are, chemically, non-homogeneous; moreover, various solvents (alcohol, ether, acetone, etc.) dissolve certain constituents out of them, leaving others.

* Homogeneity, in its full chemical significance, is not claimed, inasmuch as the composition of cellulose itself remains a matter of doubt. The quality is urged from the technical standpoint, in relation to the properties of other smokeless powders. It is possible that a solvent may be found capable of separating pyro-collodion fractionally; but pyro-collodion insoluble in ether or alcohol, but soluble in a mixture of these substances, is far more homogeneous than other forms of nitro-cellulose or any of the nitro-glycerine powders, inasmuch as the latter are readily capable of fractional subdivision.

The same may be said of present-day types of nitro-cellulose powders; alcohol dissolves out of them the nitro-celluloses of lower nitration; a mixture of ether and alcohol, the collodions, leaving the excess of highly nitrated cellulose undissolved. Pyro-collodion,* however, surrenders no part of its substance to alcohol, while it is wholly soluble in a mixture of ether and alcohol. This chemical homogeneity of pyro-collodion, taken in the sense in which it is stated to be employed, plays an important rôle in its combustion; for there are many reasons for believing that in the case of the combustion of those physically but not chemically homogeneous substances, such as the nitro-glycerine powders (ballistite, cordite, etc.), the nitro-glycerine portion is decomposed first and the nitro-cellulose portion burns subsequently, in a different layer of the powder.† It is to be added that the homogeneity of pyro-collodion possesses a direct bearing upon the uniformity of ballistic results developed by its use.

Besides chemical homogeneity, pyro-cellulose and the powders prepared therefrom possess a second distinguishing quality, viz. that for a given weight of their substance they develop a *maximum volume of evolved gases*, the latter being measured at a given temperature and pressure. This new conception involves certain intricacies and complexities, and may be discussed to some degree of fulness, in what relates to nature and amount of gases evolved upon the decomposition of powder.

According to the law of Avogadro-Gérard,‡ the chemical equivalents or quantities of matter expressed by simultaneous chemical formulæ (*e. g.*, $H_2O = 18$, water; $CO = 28$, carbonic oxide; $CO_2 = 44$, carbonic acid; $N_2 = 28$, nitrogen) occupy at a given

* Under the assumption that the remainder of the solvent is wholly expelled from the powder.

† The experiments of Messrs. I. M. and P. M. Tcheltsov at the Scientific and Technical Laboratory show that for a given density of loading, the composition of the gases evolved by nitro-glycerine powders varies according to the surface area of the grains (*i. e.* the thickness of strips or cords), a phenomenon not to be observed in the combustion of pyro-collodion powder. There is only one explanation for this, viz. that the nitro-glycerine, which possesses the higher rate of combustion (Berthelot), is decomposed sooner than the nitro-cellulose dissolved in it. This is the reason why the nitro-glycerine powders destroy the inner surfaces of gun chambers with such rapidity.

‡ The development of this law is given in "Principles of Chemistry," by D. Mendeléef, 6th ed., 1895, chap. 7.

temperature and pressure the same volume as is occupied by two parts by weight of hydrogen $H_2 = 2$ (its molecular equivalent). Consequently, if we possess the full chemical equation of combustion of a substance or mixture of substances, for which the products are gases or vapor, it is easy to calculate the volume occupied by these products at a given temperature and pressure. For example: the combustion of black powder may be expressed typically by the equality,

$$2KNO_3 + S + 3C = K_2S + 3CO_2 + N_2.$$
$$\text{Weight, } 2.101 + 32 + 3.12 = 110 + 3.44 + 28 = 270.$$
$$\text{Volume in form of gases, } 3.2 + 2 = 8.$$

That is, for 270 parts by weight of powder ingredients 8 volumes of gas* are formed, or 29.6 volumes for 1000 parts by weight of explosive. Brown powder (cocoa) represents (in its greater progressiveness of combustion and in certain other respects) a partial transformation from black to smokeless powders, and is characterized by the partial carbonization of its charcoal (which contains much hydrogen and approximates to a composition C_5H_4O), and by the small amount of sulphur entering into its

* If the weights of the equivalents be expressed in grams we may ascertain the volume of gas evolved in litres, when the pressure P (in millimetres of the mercurial column) and the temperature t (in degrees Celsius) are known. Thus, as two equivalent weights of hydrogen and the equivalent of each gas occupy at a temperature $t = 0$ and a pressure $P = 760$ mm. a volume of 22¼ litres, then for t and P this volume becomes

$$22\tfrac{1}{4}\,(1 + 0.00367\,t)\,\frac{760}{P}.$$

Consequently *one* volume, expressed in grams, occupies, approximately,

$$\frac{11.1 + 0.0407\,t}{p}\ \text{litres},$$

where p corresponds to the number of atmospheres, each of 760 mm. at 0°; i. e., $p = \frac{P}{760}$. Thus, in our example, if $t = 2000°$ and $p = 2500$ atm., the 8 volumes of gas produced by the combustion of 270 grams of powder occupy an actual volume of

$$8.\ \frac{11.1 + 0.407\ .\ 2000}{2500} = 0.296\ \text{litre}.$$

At 0° and a pressure of 1 atmosphere we attain a volume of 88.8 litres for 270 grams. In this manner it is easy to proceed to the value V_{1000} given in the text, the actual volume of evolved gases per kilogram of powder.

composition. Its mode of combustion may be expressed approximately as

$$6KNO_3 + 2C_5H_4O = 3K_2CO_3 + 7CO + 4H_2O + 3N_2,$$
$$6.101 + 2.80 = 3.138 + 7.28 + 4.18 + 3.28 = 766,$$
$$\text{Volume of gases,} \quad 7.2 + 4.2 + 3.2 = 28.$$
$$V_{1000} = 36.5,$$

or as follows:

$$4KNO_3 + C_5H_4O + S = K_2SO_4 + K_2CO_3 + 4CO + 2H_2O + 2N_2,$$
$$\text{Weight} = 516, \quad \text{volume of gases} = 16,$$
$$V_{1000} = 31.0.$$

It is evident, then, that the gas volume corresponding to brown powder is nearly 34,—greater than that for black powder; whence originates the preference generally accorded to brown powder over black.

In a similar manner we have for the complete (typical) combustion of nitro-glycerine,

$$4C_3H_5N_3O_9 = 12CO_2 + 10H_2O + 6N_2 + O_2.$$
$$\text{Weight, } 4.227 = 12.44 + 10.18 + 6.28 + 32 = 908.$$
$$\text{Volume of gases} = 12.2 + 10.2 + 6.2 + 2 = 58.$$
$$V_{1000} = 63.9.$$

If we present in the same manner the decomposition of a type nitro-cellulose of high nitration, such as Abel's tri-nitro-cellulose, $C_6H_7(NO_2)_3O_5$, we obtain

$$2C_6H_7N_3O_{11} = 3CO_2 + 9CO + 7H_2O + 3N_2.$$
$$\text{Weight, } 2.297 = 3.44 + 9.28 + 7.18 + 3.28 = 594.$$
$$\text{Volume of gases} = 3.2 + 9.2 + 7.2 + 3.2 = 44.$$
$$V_{1000} = 74.1.$$

If the typical combustion of this nitro-cellulose be presented by the equality

$$2C_6H_7N_3O_{11} = 10CO_2 + 2CO + 7H_2 + 3N_2,$$

that is, if we assume that water is not formed, and that the oxygen combines wholly with the carbon, then the V_{1000} remains unchanged, as the volume of gas formed ($22.2 = 44$) remains as before. Therefore we need not stop to consider how the oxygen is distributed between the carbon and hydrogen in the products of combustion, as the value of V_{1000} does not vary.*

* It is another matter if a portion of the oxygen continues in combination with the nitrogen, of if the oxygen proves insufficient to convert all

If, for nitro-cellulose of high nitration we substitute Eder's penta-nitro-cellulose, $C_{12}H_{15}(NO_2)_5O_{10}$, which corresponds to a content of 12.75 per cent. nitrogen, and to the composition of ordinary nitro-cellulose employed for smokeless powders, we obtain a greater evolution of gas, for

$$2C_{12}H_{15}N_5O_{20} = CO_2 + 23CO + 15H_2O + 5N_2.$$
$$\text{Weight, } 2.549 \quad = 44 + 23.28 + 15.18 + 5.28 = 1098.$$
$$\text{Volume of gases} = 2 + 23.2 + 15.2 + 5.2 = 88.$$
$$V_{1000} = 80.1.$$

The increase in volume of gas hereby realized is due to the fact that the quantity of carbonic acid evolved is diminished, while that of carbonic oxide is increased, which causes an increase of total gas volume, since, for the equality

$$C + O_2 = CO_2, \quad V_{1000} = 45.5,$$

and for the equality

$$C + O = CO, \quad V_{1000} = 71.4.$$

If we descend to a lower nitration and consider Eder's tetra-nitro-cellulose, $C_{12}H_{16}(NO_2)_4O_{10}$, we have no longer the case of complete combustion; for 20 equivalents of oxygen are required to convert 12 of carbon and 16 of hydrogen into gaseous products and vapors, while there are but 18 of oxygen available, unless we assume the products of combustion as CO, H_2O, and H_2.* It is known, however, that in the case of combustion of

the carbon and hydrogen into gases; that is, if hydrocarbons are formed; but this becomes a case of incomplete combustion. Such conditions have a certain bearing upon the combustion of smokeless powders, especially when the solvent is not completely expelled; but, on the one hand, the quantity of hydrocarbons formed is relatively small, and on the other, they are formed (as also compounds of carbon and nitrogen, as cyanogen), in relatively small quantities, for all powders, even when the latter contain an excess of oxygen. In considering type forms of combustion there is no need of investigating secondary conditions of this class, especially as by so doing we are diverted from the direct study of the general problem.

*In the latter case (without formation of carbon) the decomposition would be:

$$C_{12}H_{16}N_4O_{18} = 12CO + 6H_2O + 2H_2 + 2N_2.$$
$$\text{Weight, } 504 \quad = 12.28 + 6.18 + 2.2 + 2.28 = 504.$$
$$\text{Volume of gases} = 12.2 + 6.2 + 2.2 + 2.2 = 44.$$
$$V_{1000} = 87.5.$$

But typical combustion, according to such an equation, is practically impossible; carbon and hydrocarbons are formed, and the combustion

carbohydrates low in oxygen the latter combines with the hydrogen, from its greater affinity for that substance, leaving a part of the carbon deposited in an uncombined state. Consequently, such conditions do not correspond to complete combustion.

The formation of CO_2 shows that there is a certain excess of oxygen in penta-nitro-cellulose; whereas typical combustion, corresponding to maximum gas volume, requires all carbon to be converted into carbonic oxide. Such typical combustion is afforded by pyro-collodion, whose composition, as shown, corresponds to the formula $C_{30}H_{38}N_{12}O_{49}$, as is shown by the equation,

$$\underset{\text{Cellulose.}}{5C_6H_{10}O_5} + \underset{\text{Nitric acid.}}{12HNO_3} = \underset{\text{Pyro-cellulose.}}{C_{30}H_{38}(NO_2)_{12}O_{25}} + \underset{\text{Water.}}{12H_2O}.$$

In typical combustion it corresponds to the following equality:

$$\begin{aligned} C_{30}H_{38}N_{12}O_{49} &= 30CO + 19H_2O + 6N_2. \\ \text{Weight, } 1350 &= 30.28 + 19.18 + 6.28 = 1350. \\ \text{Volume of gases} &= 30.2 + 19.2 + 6.2 = 110. \\ V_{1000} &= 81.5. \end{aligned}$$

Before proceeding further, we desire to call attention to the fact that, whereas for brown powder we realize a volume of 34 approx., we have here a volume of 81.5, whence, judging from volumes of evolved gases, pyro-collodion should prove 2½ times more powerful than brown powder. Actual experiments show

that actually does occur is intermediate in character to that expressed by the above and by the two following equalities—

$$2C_{12}H_{16}N_4O_{18} = C_4 + 20CO + 16H_2O + 4N_2.$$
$$2C_{12}H_{16}N_4O_{18} = 22CO + 14H_2O + C_2H_4 + 4N_2.$$

For the first, $V_{1000} = 79.4$; for the second, 81.4; the mean of the two latter is 80.4; of all three, 82.4. This quantity is close to that afforded by penta-nitro-cellulose and pyro-collodion. In this manner may be explained the phenomenon that upon the combustion of nitro-cellulose containing a little less than 12.5 per cent. nitrogen or of pyro-collodion containing a certain amount of unevaporated solvent (which is equivalent to a lowering of nitration), results are obtained that approximate to those produced by pyro-collodion powder, although velocities and pressures are somewhat lowered. The existence of this phenomenon depends upon the homogeneity of the powder; whence it follows that it is better to have a content of a little less than 12.5 per cent. with a homogeneous powder than a content of above 12.5 per cent. nitrogen with the powder non-homogeneous, and that the best results are developed by homogeneous pyro-collodion of nitration N = 12.4 per cent.

that the powders stand in about this relation to one another. In units of energy per unit for weight of explosive we have

	Pyro-collodion powder.	Brown powder.	Ratio.
47 mm. R. F. about	220	81.5	2.7 : 1.
9-in. gun, "	223	90.7	2.5 : 1.
12-in. gun, "	210	93	2.3 : 1.

From this it is evident that our computed value of V_{1000} is in complete accordance with actual experimental results.

In this manner we may consider it as proven that, for a *given temperature and pressure, pyro-collodion develops a greater volume of gases* (and vapor) than is developed by black or brown powder (for which $V_{1000} = 30$), and even greater than for *powders prepared from the more highly nitrated forms of nitro-cellulose and for the nitro-glycerine powders.**

In order to establish the full significance of the above deduction, it remains to show (1) that from the standpoint of practical applicability we can foresee no other material capable of developing as great a value for V_{1000} as pyro-collodion; (2) that the physico-chemical and ballistic qualities necessary in a smokeless powder are developed by pyro-collodion, not in a less, but in an

*The rapid, simple and novel method of comparing the force of explosives herein employed was first suggested and used by me in 1892. It was developed through comparison of the composition of smokeless powders and of their products of combustion and of the results of experimental firings made at the Laboratory. Although I see clearly that not only the volumes of products of combustion, but also their temperatures, must be taken into account in a complete analysis of phenomena attending the decomposition of smokeless powders, nevertheless I purposely give preference in these investigations to phenomena relating to volumes of gases evolved, not only on account of the simplicity of the latter and their direct accordance with ballistic results, but for the reason that with present methods for estimating temperatures developed by explosives (and these methods are unreliable) it becomes necessary to make numerous arbitrary assumptions (especially in relation to specific heats of gases and vapors at high temperatures); while for volume calculations we have definiteness of composition as a starting point; and if there be any assumption to be made, it relates to the distribution of the oxygen between the carbon and hydrogen, which, from the chemical standpoint, it is not so material,—and as far as it relates to volume it is of little significance. In all cases, however, I present but the elementary comparisons of performances of powders, as the fuller treatment of the subject does not constitute the object of my investigation.

equal or greater degree than by other materials employed as smokeless powders; (3) that the estimate of ballistic efficiency of a smokeless explosive, through consideration of its volume of evolved gas, without regard to conditions of temperature, leads us into no error, although it would at first appear that temperature would have a direct effect upon the practical qualities of a powder.

I. When smokeless powder was first discovered, so many schemes were afloat for meeting general demands that up to the present time there remain as open questions—which form of smokeless powder is the superior, and whether new and still more efficient forms may not be looked for in the future. In order to reply to these inquiries it will be necessary first to glance over the compositions of materials capable of conversion into smokeless powders under the following assumptions: (1) that they leave no solid residue after combustion, and that their gases exercise no injurious effect upon the metal of guns; (2) that they undergo no change upon keeping for long periods of time, and contain no volatile ingredients; (3) that they may be readily prepared in quantities sufficiently abundant for practical needs.

There are but few elements capable of producing gases that do not act upon metals, and, generally speaking, it is useless to try to find others besides hydrogen and nitrogen, and their compounds with oxygen and carbon, that do not act upon gun chambers at the temperatures of combustion of powder. Therefore, in general terms, the composition of those mixtures or compounds suitable for conversion into powder, may be expressed as

$$C_nH_{2m}N_2O_n.$$

The energy imparted to the projectile is derived from the conversion of the mass of the powder into gases,* the transformation being accompanied with the production of great heat. These fundamental conditions serve to limit the number of materials that are capable of conversion into smokeless powder, the limitations arising not only from the above-named practical requirements, but also from the chemical impossibility of existence of many bodies which, if obtainable, would decompose in the man-

* And is not derived from an external source of energy, such as the tension of a spring or the physical compression of gases, as in the Giffard gun.

ner requisite for efficient ballistic action. Thus, *e. g.*, there does not exist, nor can we look forward to the existence of such a polymer (in the solid or liquid form) of hydrogen H_n that would decompose into hydrogen, H_2 with a corresponding production of heat.*

If we may not look for explosives among the simplest chemical combinations of the elements, we may perhaps find them among those compounds of nitrogen and hydrogen which stand in the same relation to ammonia, NH_3, as the hydrocarbons to methane, CH_4. We should thus have corresponding to ammonia the series N_nH_{n+2} (ex., diamide N_2H_4, triamide N_3H_5, etc.) and the series N_nH_n, N_nH_{n-2}, etc. As the representative of the latter we have, for $n = 3$, the nitro-hydric acid of Curtius, N_3H, which actually is a very explosive body, and which forms salts, *e. g.* with ammonium $N_3(NH_4) = N_4H_4$, which is also explosive, decomposing into the gases nitrogen and hydrogen with the evolution of heat, although ammonia itself it not susceptible of explosive decomposition, but absorbs heat in the reaction. If such compounds could be easily prepared, and if they possessed the qualities necessary to an efficient smokeless powder, such as non-volatility, good keeping quality, progressiveness in combustion, etc., they would prove especially suitable for conversion into smokeless powders, as the corresponding values of V_{1000} would be greater than for other powders. Thus we should have for nitro-hydric acid,

$$2N_3H = H_2 + 3N_2.$$
$$\text{Weight, } 2.43 = 2 + 3.28 = 86.$$
$$\text{Volume of gases, } 2 + 3.2 = 8.$$
$$V_{1000} = 93.0.$$

For N_nH_n the volume would be still greater, as $V_{1000} = 133.3$. But even if they could be conveniently prepared from readily

* If such a substance existed, then its decomposition, according to the equation $H_{2n} = nH_2$, would afford a weight 2n for a volume 2n; that is, V_{1000} would be equal to 1000, the greatest possible value. For nitrogen under similar conditions we would have $V_{1000} = 71.4$, or less than for pyro-collodion. But the existence of such a polymer is highly improbable. If argon (vid. Mendeléef, Principles of Chemistry, 6th ed. 1895, p. 749) were the polymer of nitrogen, N_3, its conversion into nitrogen could only be accomplished through the absorption of heat; *i. e.* it would find no place in the category of "explosive" bodies (to which ozone possesses a relation).

procurable materials it would be useless to consider such products as available for conversion into smokeless powders, for the reason that they do not decompose through gradual or progressive combustion, as is indispensable in a smokeless powder, but detonate or decompose with extreme suddenness; whence, while they might prove suitable for filling mines or shells, they are unadapted for use in cannon. This property of progressive combustion or decomposition in successive strata is possessed only by those substances containing both combustible ingredients and ingredients capable of effecting progressive combustion, such as carbon and hydrogen, which are consumed by the oxygen that is held in close proximity to them but which is not in direct combination with them.

(*To be continued.*)

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE OBRY DEVICE FOR TORPEDOES.

By J. H. Sypher, Ensign, U. S. Navy.

The Obry device for steering torpedoes is an application of the principle of the gyroscope to the Whitehead torpedo. These torpedoes, before the installation of this device, had no vertical rudders, their course in a straight line being insured by permanently clamping two vertical vanes upon the horizontal tail-piece, the proper angle being determined by a series of trial runs. The Obry gear requires the placing of two rudders in the vertical tail-piece, one in the upper and one in the lower half. The combined area of these rudders is equal to twice the area of the fixed vanes, so that their action will overcome that of the vanes. It is found in practice that it makes no difference whether the vanes are on or off, or, if on, at what angle they are set.

In the Howell torpedo the driving mechanism is itself a gyroscope, which, revolving in the plane of the line of fire, tends to keep the torpedo in that line. If for any cause it be turned aside, the resultant of the forces causes the torpedo to roll, which, by the action of a transverse pendulum, moves the vertical rudders and brings the torpedo back to its course. In the Obry device the gyroscope is mounted on gimbals, so that, no matter how the torpedo may turn, the gyroscope remains in the plane in which it was first started. The torpedo turning about this, or, what is relatively the same thing, the gyroscope turning in the torpedo, moves the valve of a steering engine or servo-motor which works the vertical rudders.

This is the principle upon which the device works. The arrangement of the parts by which this is accomplished is not very complicated, but the greatest care in the making and assembling

is necessary. All weights are counterbalanced, and the bearings are such as to reduce friction to a minimum.

In the earlier types the device was mounted in the after balance chamber on the bulkhead abaft the engine-room, and the winding socket was in the side of the torpedo. The new torpedoes for this Government, however, will be fitted with the device mounted on the floor of the balance chamber, accession being given by means of a door in the bottom, similar to the engine-room door, except that it is water-tight. The winding socket also will be in the bottom of the torpedo. This change of position necessitates some changes in the arrangement of the parts, notably in the actuating mechanism, but the general principle remains unchanged, and I shall endeavor in what follows to describe briefly the arrangement, noting where the old and new types differ.

The device consists essentially of three parts—the gyroscope, the actuating gear, and the servo-motor that works the vertical rudders.

The gyroscope or fly-wheel is made of close-grained, homogeneous bronze, carefully cast so that the metal is of the same density in all parts, and then turned down smooth, great care being taken to get the geometrical center and the center of gravity exactly coincident. The axle is mounted in jeweled bearings in a gimbal ring, which is in turn mounted in a second ring, and the whole mounted on a bronze standard. The gyroscope is thus left free to move in any direction irrespective of the course, inclination or roll of the torpedo.

The fly-wheel is caused to revolve rapidly by means of a pinion on its axle which engages with a large cog-wheel, on the spindle of which is wrapped a stiff steel wire spring. There is a piece cut out from the rim of the cog-wheel, making it rather a toothed segment than a complete wheel, and in this space the pinion revolves after being started by the toothed part of the wheel.

In the earlier devices the spindle of the cog-wheel on which the spring is wound was horizontal, being above and parallel to the axle of the gyroscope. The cog-wheel thus engaged directly with the pinion. The end of the spindle was fitted in a bearing in the side of the torpedo, with a squared recess sunk in it to take the wrench for winding the spring. The device as fitted to our torpedoes has the spindle vertical and the winding socket in the bottom of the torpedo. In order that the cog-wheel may engage

with the pinion it is changed into the segment of a crown wheel, or circular rack, shaped like an inverted saucer, with teeth around the edge, and a piece taken out of one side. The spindle, which is hollow, passes up through the center and has a rod sliding in it which operates an important part of the mechanism.

This is the arrangement of levers for locking the gyroscope, so that when it is not in operation it will be held in a plane parallel to the axis of the torpedo. After it has been given its rapid revolution, and is capable of maintaining its plane of rotation unchanged, it is released, so that the torpedo may be free to turn about it as it will.

The first locking of the gyroscope is done by the motion of the rod before mentioned, the inner end of which projects beyond that of the spindle about one-quarter of an inch. The rod is held in this position by its outer end being pressed against a covering plate screwed into the shell of the torpedo over the end of the spindle. As this covering plate is screwed out, the rod follows it under the influence of a spring until its inner end is flush with that of the spindle. This motion allows two little levers with flat ends or shoe-pieces to come down under the action of springs on the two gimbal rings over their pivots, holding them at right angles to each other and placing the gyroscope in a plane parallel to the axis of the torpedo. The gimbal rings are held thus as long as the covering plate remains off, that is, while the spring is being wound.

The winding is done by a square-ended wrench fitting in the socket in the end of the spindle, which wrench is bored out to fit over the protruding end of the rod. A little less than one turn suffices to wind the spring, in doing which the segment is turned so that its teeth just engage on the edge of the blank space with those of the pinion. While the winding is going on. the gyroscope is held steady in its plane by the little levers on the gimbal rings, but it is necessary to provide some device for holding it after the covering plate is screwed in (which pushes in the rod in the spindle and lifts the little levers), and especially while the toothed segment is sweeping across the pinion and giving the gyroscope its momentum. This is done as follows:

There is, on the spindle and turning with it near its outboard end and just within the shell of the torpedo, a plate containing on its flat surface a cam on which rests the short end of a bell-

crank lever. The other end of the bell-crank lever is fitted with a little hopper-like receptacle which takes over a stud on the inner gimbal ring in a prolongation of the axis of the gyroscope. This effectually prevents any motion of the gyroscope except that of revolution, and the cam is so shaped that the short end of the bell-crank lever is not moved (which action releases the gyroscope) until the segment has swept across the pinion and come to the blank space, where it brings up against a stop. In other words, the cam is a circle with one little jog in it at a place corresponding to the blank in the segment. Thus, when the spring has been wound and the covering plate screwed in, the gyroscope is held only by the hopper on the bell-crank lever. When the torpedo is fired, and after the gyroscope is set spinning, this is drawn back, leaving the gimbals perfectly free.

The releasing of the spring when the torpedo is fired, and the stopping of the segment at the proper place, is also done by the plate containing the cam. Screwed into this plate near its circumference is a small pin, which, when the spring is wound, is caught and held by a pawl. A series of levers connect this pawl with the main starting lever above the valve group. When the torpedo is fired, the motion of this lever is transmitted to the pawl, releasing the pin and allowing the segment to revolve under the influence of its powerful spring. The pinion being so small is thus given a very rapid rotation, which is the speed of the gyroscope.

Since the motion of the starting lever also starts the gyroscope, it must be remembered to make all tests of the torpedo before the Obry device is wound. If this is not done and the gyroscope is set spinning during the tests, one must wait fifteen or twenty minutes until it stops, to prevent which it should not be wound up until just before the torpedo is pushed home in the tube.

To insure the stopping of the segment at the right moment with the pinion in the blank space, and at the same time to obviate any shocks to the mechanism, the plate above-mentioned on the spindle is made cam-shaped in its periphery as well. The cam is approximately a circle placed eccentrically to the spindle, but for lightness, all except the part farthest from the center of rotation, which is the only part used, is cut away.

When the segment is released and revolves until the pinion

reaches the blank space of the segment, the cam begins to take against a small rubbing piece mounted on a block of rubber, which, as it turns, brings the segment to rest by increasing pressure without concussion. At the same time the other cam has lifted the hopper on the bell-crank clear of the gimbal ring and the gyroscope is free and in motion. We have now to see how its motion relative to the torpedo is transmitted to the vertical rudders. This is done by a steering engine or servo-motor and valve which lie close to the lower pivot of the outer gimbal ring.

The valve consists of an inner cylinder which turns in a casing, one direction opening air to one side of the piston of the servo-motor and exhaust to the other, and the other direction reversing this.

Thus the piston moves back and forth according as the valve is turned, and is held in either position by the pressure of the air upon it. The tiller-rod is connected directly to the piston-rod, and it can be easily seen how the rudders are worked. They have no midship section. They are either hard a-port or hard a-starboard all the time, and go from one to the other as the air is opened to one side or the other of the piston; that is, as the valve is turned one way or the other. This gives the torpedo a snaky course, which may be seen plainly by the air-bubbles in its wake, but as the gyroscope acts immediately upon the torpedo's head being turned from the straight line, the curves are of small size.

This is the case in ordinary running, but it may happen that the torpedo be broadly deflected from its course either by an obstacle, or, as is usually the case, by being fired from a boat at high speed. When this happens the gyroscope makes a large angle with the axis of the torpedo, but there is no necessity for turning the valve of the servo-motor to so great an extent. In fact, the sensitiveness of the device consists in its acting when turned through small angles. A very slight motion of the valve is all that it necessary to operate the servo-motor, the air-passages of which are no larger than coarse hairs, and only enough motion to open and close these is required. Thus in the cases mentioned, if the valve and gyroscope were rigidly connected, either the valve would be turned too far, or, if checked, the gyroscope would be deflected from its plane of rotation.

To prevent this, and at the same time to allow a large range of motion for the gyroscope, the following arrangement is adopted:

On the pivot of the outer gimbal ring there is clamped a short arm terminating in a small stud. On the end of the valve stem there is at the same height as this stud a pair of jaws in which the stud fits. The shape of these jaws is such that after the arm has turned the valve stem through a small angle it goes clear. The rudders have thus been put hard over and the valve is left in that position until the arm returns as the torpedo answers her helm and puts the rudders over the other way. This arrangement also corrects any little deflection the work of turning the valve may have given to the plane of rotation of the gyroscope, but when the valve is clean and in good working order it has never been found that there is any deflection.

The short arm on the pivot of the gimbal ring is not a permanent fixture there, but may be clamped at any desired angle to the gyroscope. This permits a much broader field of use for the torpedo than heretofore. By properly adjusting this arm, a torpedo may be fired abeam from a bow tube, or ahead or astern from a broadside tube. Under-water tubes are also made feasible without any extra attachments.

Suppose it were desired to fire broad on the bow from a fixed broadside tube. The Obry gear would be removed, the short arm on the gimbal ring turned through an angle of forty-five degrees and the device then replaced in the torpedo. Now when the torpedo is fired the rudders will remain hard over until the torpedo has turned through an angle of forty-five degrees, which will bring the arm within the jaws of the valve stem, and the torpedo will then begin its snaky course forty-five degrees from the direction of the tube.

To fire right ahead or astern the arm should be turned through ninety degrees.

In regard to the servo-motor it may be said that such difficulties as have arisen with the device can be traced to this cause.

It must be made so sensitive that any foreign substance that gets in is enough to interfere with its efficient working.

The air does not come to it directly from the air-flask of the torpedo, but first passes through a reducing valve, which reduces the pressure from 1350 pounds in the flask to 65 pounds at the servo-motor. This expanding and consequent cooling of the air condenses any moisture it may contain, and even a single drop of water in the fine passages may cause trouble. Attempts have

been made to fit filters or strainers to the air pipes to prevent water and dust from reaching the valve, but thus far without any great amount of success. If experience proves these to be necessary, I have no doubt something of the sort will be found to give satisfaction. The air after leaving the servo-motor exhausts directly into the balance chamber, which should be opened after each run to permit the excess of pressure to escape.

This little device, weighing in all about eight pounds and occupying an exceedingly small space, will almost revolutionize torpedo warfare, giving to a weapon whose chance of a successful shot hitherto has been almost as uncertain as the throw of a die, an accuracy but little less than that of a modern great gun.

It removes from the mind of the torpedo officer all thought of the allowances to be made for speed and rolling of his own vessel, combined with the state of sea and bearing of the enemy—a calculation containing so many variables as to put it almost beyond the reach of any one man's experience—and permits him to train his tube in the same manner that a gunner trains his gun, directly at the point he wishes to hit, making allowance only for the speed of the enemy. The allowance must be greater as the speed of the torpedo is less, but the principle remains the same.

The advantages are so many that even the excessive cost of the device—about one-third that of the whole torpedo—has not prevented nearly all the great powers from adopting it; for naval officers will welcome at any cost whatever will serve to relieve their minds of some of the strain of a torpedo attack.

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SEARCH CURVES.—SOME APPLICATIONS AND LIMITATIONS.

By Richard Wainwright, Lieutenant-Commander, U. S. N.

The three principal search curves are the meeting curve, the departure curve, and the arrival curve.

The meeting curve is a circle so constructed that the distance from two points to any point on the curve contains the same ratio; thus, in Fig. 1 the distance between A and B is 60 miles. In the first curve the vessel at A is supposed to move at the rate of 20 miles, and the vessel at B at the rate of 10 miles. If they both move toward each other they meet at a point 40 and 20 miles from A and B respectively. The distance of the center of the circle from the point of first meeting is found by the following formula:

Meeting Curve.

V = speed of faster vessel.

V' = speed of slower vessel.

$r = \frac{V'}{V}$.

D = distance between vessels.

a = distance run by faster vessel to point of meeting.

b = distance run by slower vessel to point of meeting.

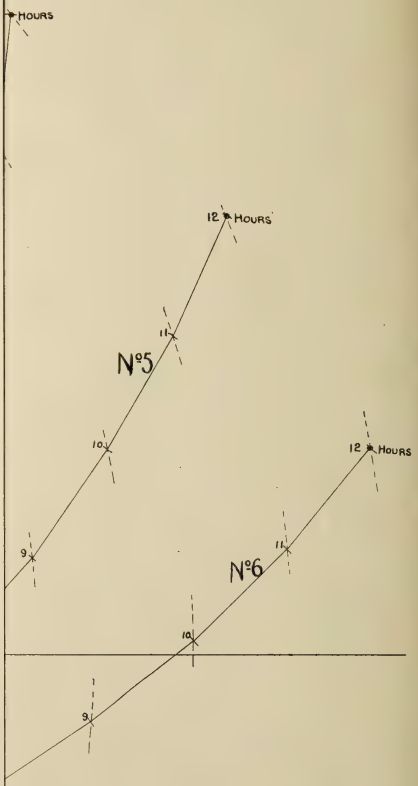
c = distance of center of meeting curve from point of meeting.

$$a = \frac{D}{r+1}. \qquad b = \frac{rD}{r+1}. \qquad c = \frac{rD}{1-r^2}.$$

At every point on this circle the distance from B divided by the distance from A is equal to r.

By means of this circle, two vessels, knowing the distance

FIG. 1.


HOURS
12 HOURS
11
Nº5
10
9
12 HOURS
11
Nº6
10
9

apart and their relative speeds, can form a rendezvous, choosing the shortest, longest, or intermediate distances; and either vessel can select a point where he will meet the other if he knows its course. In Fig. 1 the curves are made for speeds for the vessel at B varying from 10 to 15 miles, with a uniform speed of 20 miles for the vessel at A.

The departure curve furnishes the means for finding a vessel at a known distance away, the relative speeds of the vessels being known, and the course unknown, or only known within certain limits. Fig. 2 shows the departure curve, the distance between the vessels being 60 miles, the vessel at A having a speed of 20 miles, and the vessel at B having a speed varying from 10 to 15 miles. The first point in the curve is on the line joining AB and at the point where they would meet if steaming toward each other ($a = \frac{D}{r+1}$). Each succeeding point (at intervals of 1 hour) is found by means of drawing a circle from B with a radius equal to the number of miles the vessel could steam in that time, and taking the point of intersection on this circle with a circle of a radius of 20 miles struck from the previous point.

It is seen from Fig. 2 that A starts to seek for B at a distance of 60 miles, with the relative speeds of 20 and 10 miles, if B moves toward A, A will meet B on a line joining AB, and at the end of the second hour. B taking any other course will be met by A at some point on the upper curve marked 3, 4, 5, 6, etc. (at the end of the third, fourth, etc., hours), and A can make a complete search of 180° in 12 hours. The nearer B's speed approaches that of A, the smaller the sector becomes that A can search in 12 hours; and with B going 15 miles, A can search but little over a 90° sector. With such a method of search there are too many chances of accidents to make it wise to continue the calculations over 12 hours under ordinary circumstances. The following will be seen in examining Fig. 2: With the distance equal to 60 miles and with the speed of the slower vessel of 10 miles, the searching vessel must have a speed of 20 miles or over unless the course of the vessel sought is known to be within less than 180°; and with the same distance, if the speed of the chase is 15 miles, the speed of the chaser must be 20 miles or over, unless the course of the chase is known within 90°; and if the speed of the chase is known to be between

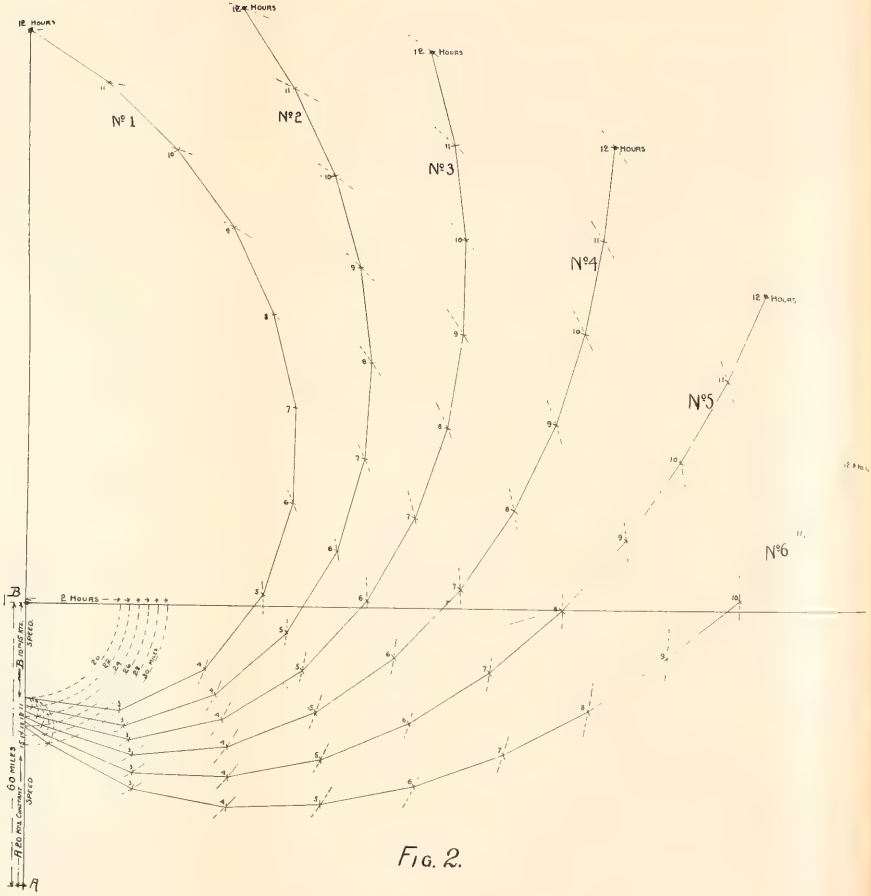


FIG. 2.

apart and their relative speeds, can form a rendezvous, choosing the shortest, longest, or intermediate distances; and either vessel can select a point where he will meet the other if he knows its course. In Fig. 1 the curves are made for speeds for the vessel at B varying from 10 to 15 miles, with a uniform speed of 20 miles for the vessel at A.

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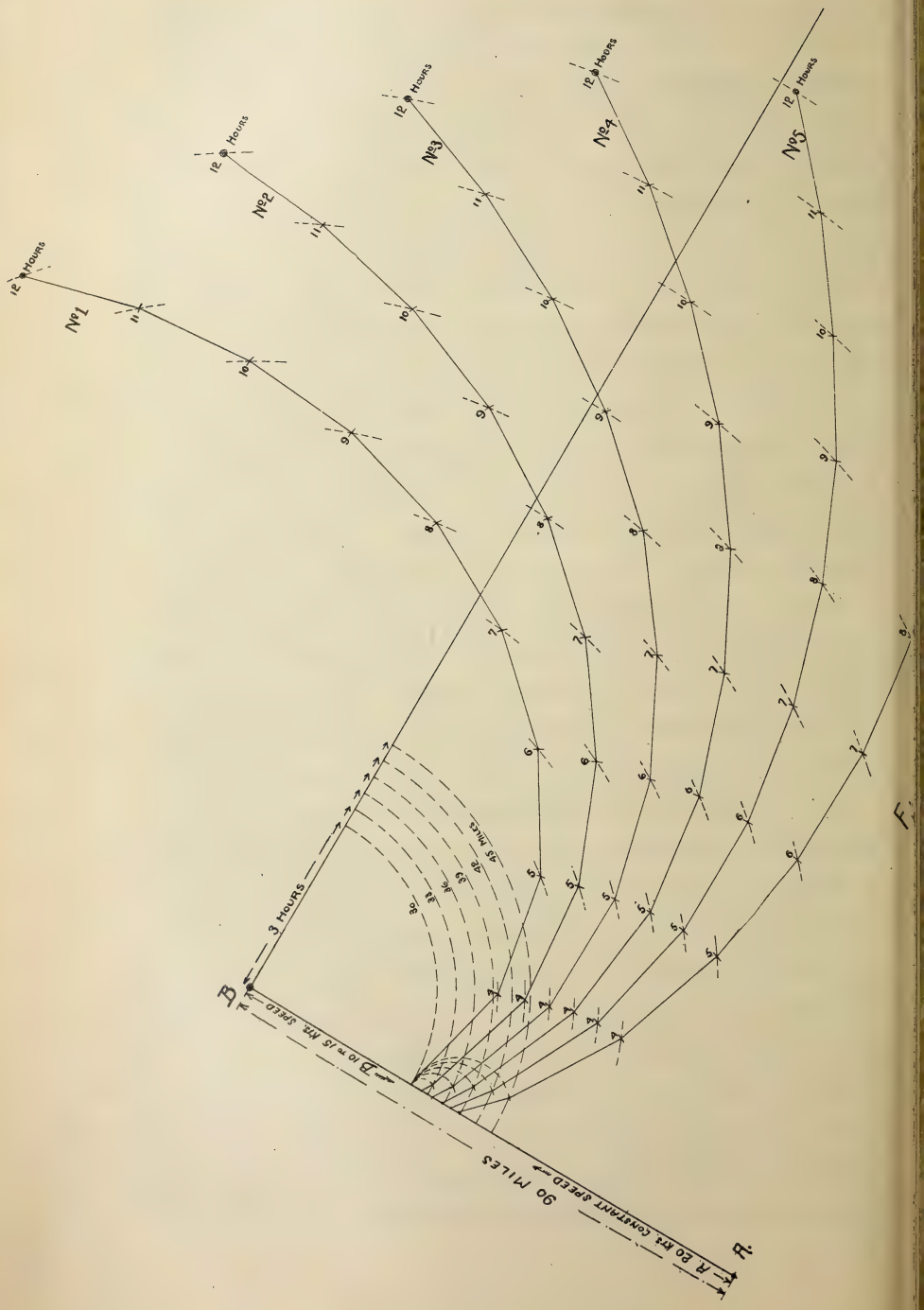
10 and 15 miles and the course is known within 90°, three vessels should be sufficient to conduct the search.

Fig. 3 shows the departure curve with the same relative speeds between the chase and chaser, but the distance apart is 90 miles. The other sectors covered by the chaser are much smaller, and it would require many more vessels to cover the same sector with the same uncertainties as to the speeds of the chase as mentioned before—that is, 10 to 15 miles. Fig. 4 shows the departure curve with a distance of 120 miles between the two vessels. It shows the increased difficulties for the chaser. Fig. 5 shows the departure curve, the vessels being 120 miles apart and the relative speeds 10 and 20 miles. The middle curve is the one to be followed, the vessels both leaving their points of departure at the same time. The three upper curves are the ones to be followed if the chase leaves B 1, 2, or 3 hours later than the chaser leaves A, and the three lower curves are the ones to be followed if the chase leaves B 1, 2, or 3 hours earlier than the chaser leaves A. Should there be uncertainty as to the time when the chase takes its departure, the number of vessels necessary to conduct the search could be found from Fig. 5.

Fig. 6 shows the arrival curve. The distances between A and B are taken as before at 60, 90, and 120 miles, and the speeds of the chase as before at 10, 11, 12, 13, 14, and 15 miles, while the chaser is supposed to have the uniform speed of 20 miles. In this curve the speed of the chase is known, also the position of the point of arrival, with the time of intended arrival. In the curve constructed with $V' = 10$ and $V = 20$ and distance of 120 miles, the chaser knows that the chase intends to arrive at B at 6 P. M. and that he can steam at 10 miles. The chaser steaming at 20 miles desires to intercept him as early as possible and before he arrives at B. The vessel steaming for B may start for that point from any direction, but must leave some point 120 miles distant from B 12 hours before the time of his arrival, or at 6 A. M. The chaser leaving at 6 A. M. steers such courses as to intersect the 10-mile curves from B at each hour, and must therefore sight the chase at some point on his curve unless that vessel comes from a direction not covered by the curve. The chase having a speed of 11, 12, etc., miles, and starting from the same distance, must arrive in $\frac{120}{11}$, $\frac{120}{12}$, etc. hours.

The use of the departure and arrival curves is set forth by

Commandants Z. and H. Montichant in their "Essai de Stratégie Navale," and they use their theory most skilfully, if fallaciously, to prove the advantages of cruisers and torpedo-boats over battle-ships. They endeavor to show that the chance of one fleet keeping touch with another is so small that a weak fleet of cruisers would be as useful, if not better, than a weak fleet of battle-ships. They look upon a naval war as a great game of hide-and-seek, the stronger fleet being unable to accomplish anything as long as the weaker fleet is able to avoid combat. This is the "fleet in being" theory with a vengeance, and shows why that theory has so many opponents. The French naval writers have generally failed to understand the true theory of the "fleet in being," and have, therefore, been led to adopt the heresies of commerce-destroying and flotillas of torpedo-boats. They would lock a battle fleet up in a fortress or force it to run away if the enemy's fleet were the stronger, failing utterly to grasp the real power of an active "fleet in being." A short study of the curves is sufficient to show that if the stronger fleet has nothing to do but to chase the weaker, the war may never end. In the same way one might suppose a strong well-found army rendered useless because unable to capture or destroy a small body of the enemy's cavalry; both suppositions are equally absurd. It is a sound maxim of strategy, that the objective of the fleet is the enemy's fleet; but this must not be carried to the absurd length of allowing the stronger fleet to remain idle because the weaker fleet has long legs. A naval war will be conducted with definite objects—primarily to obtain command of the sea; this insures safety to coast commerce, and renders the enemy's coast and commerce liable to attack, not by mere raids or by solitary commerce-destroyers, but by invasions in force and by extensive blockades. To be sure, command of the sea cannot be definitely secured if the enemy's fleet run away too fast to be brought to action, and the enemy may hold local command of the sea at some distance from your fleet; but if you have undertaken your plans with sufficient force, and they are well conceived, you can provide against any real damage from his fleet and proceed with the objects you have in view, forcing him to give up his game of hide-and-seek and to attack you or remain idle, or to attempt some raid that you can make most dangerous to him and which, if successful, would have no great effect upon


No1
No2
No3
No4
No5
12 Hours
11
10
9
8
7
6
5
4
3
2
B
3 Hours
45 Miles
42
39
36
33
30
B 10 to 15 Mls. speed
90 Miles
A Po Mls constant speed
A
F

the final results of the war. This is the full question of the "fleet in being." It forces you to make the attack with a force sufficiently large to neutralize his and to accomplish your main objects. To do this it must be active, it must meet you on chosen lines, forcing you to destroy it or to relinquish your object. The "fleet in being," while it is the weaker fleet, gains all the advantage of conducting the defensive, of secure bases, short lines of communication, prompt repairs, and the aid of the guns of the advance bases. In the end the war must be settled by the result of the appeal to the guns of the fleet, and not to their heels. While France cannot maintain a battle fleet sufficient to obtain command of the sea from England, it can maintain one that is sufficient to hold the local command of her own coasts, only it must be a real battle fleet, held to active work and not locked up in fortresses. She will throw away her best chances if she acknowledges England's superiority without fighting and relies upon coast-defense vessels, cruisers, and torpedo-boats.

While a naval war will not be a game of hide-and-seek, there will be many occasions when the knowledge of the enemy's movements will be most important. The junction of fleets may be prevented or facilitated, and all the questions of chase, scouts, and videttes are likely to arise. It is here that the search curves have their value; and while it is impossible to gain mathematical accuracy in chasing, owing to the many uncertainties that enter into the question, yet by properly utilizing these curves the route can be followed that gives the most chances of success, and the probabilities can be estimated for given conditions. A more complete search can be carried on with fewer chasers by using these curves than by proceeding according to guesswork. There are many times when it would be impossible to cover a large sector in the search, owing to great distance or small advantage in speed, and yet a complete search can be made because the probable sector including the enemy's course is small, and is known to be small owing to strategical conditions.

Rear Admiral C. Marchese, of the Italian Navy, made an elaborate attack in the Rivista Marittima on the search curves as set forth in the "Essai de Stratégie Navale." The weight of his argument is that there will not be sufficient difference between the speeds of the two fleets to permit the use of the curves with advantage. No one would more quickly agree with this than

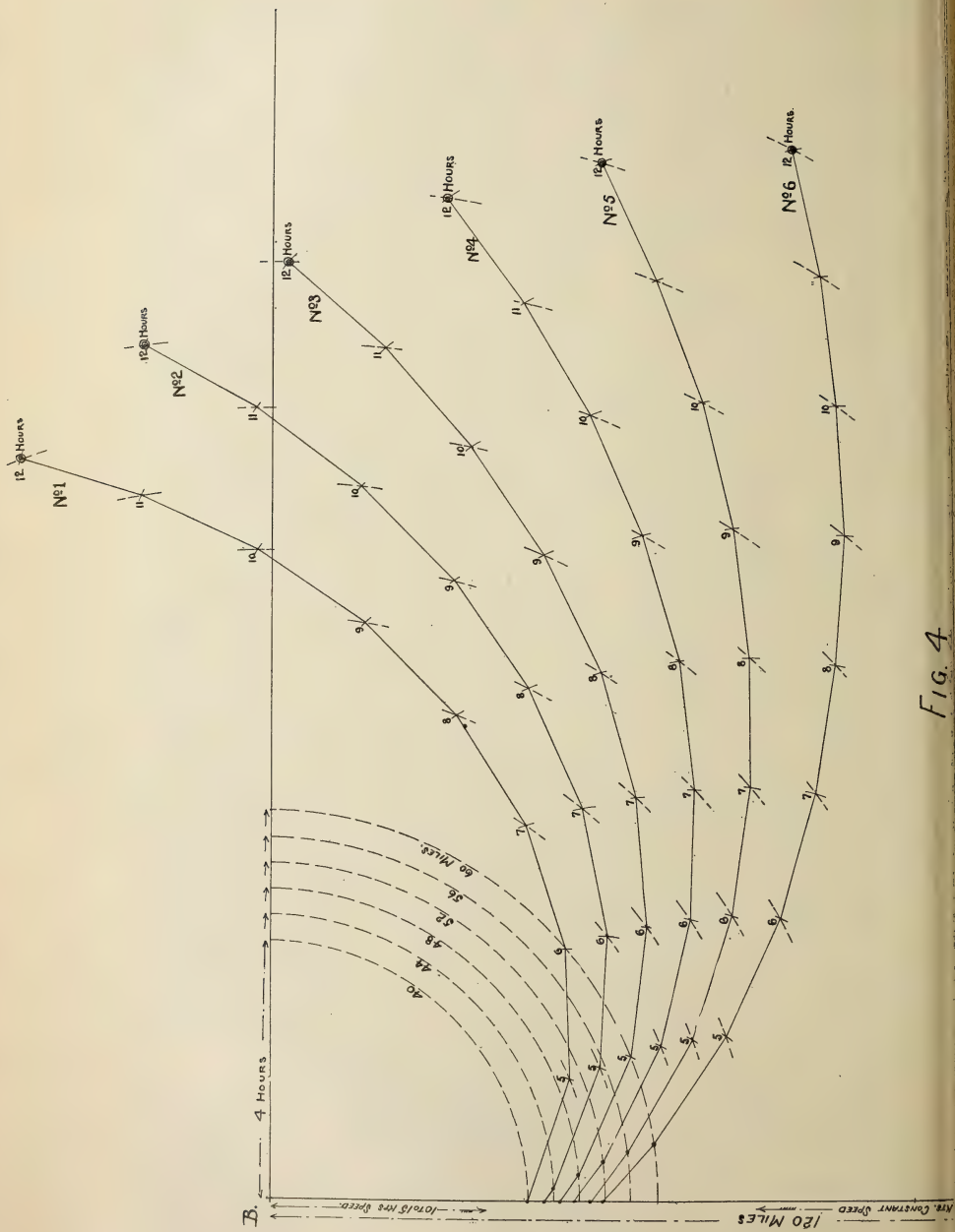

No1
No2
No3
No4
No5
No6
12 Hours
4 Hours
B
120 Miles
Nr. Constant Speed
Rotor's Nr. Speed
40
44
48
52
56
60 Miles

FIG. 4

the writers whose essay he attacks. They appreciate, and he appears to forget, that the chasers will be fast cruisers, destroyers, etc., when the chase may be a battle fleet, limited in speed by its slowest vessel and by the necessity of a long steaming radius. The chaser may have secure coaling bases close at hand, while the chase may have to fight before securing a base, and, therefore, forced to economize coal.

Admiral Marchese proposes another method of search, and does some little mathematical computations to analyze the meeting curve and illustrate his use of it. The meeting curve was analyzed by Lieutenant H. O. Rittenhouse, U. S. Navy, in the Proceedings of the U. S. Naval Institute for 1885, twelve years before the appearance of Admiral Marchese's paper. The gist of the Admiral's proposition is that the enemy's course being known within certain limits, the chaser can set a course at an angle to the direction of the line joining the chase and the chaser, and that while he will pass through the possible positions of the chase only twice, the points where his course intersects the meeting curve, the average distance from the chase will be less than in the departure curve, and that under favorable conditions this average distance will be within the space covered by the outposts of the fleet. He fails to notice that the limitations are similar to those in the case of the departure curve, and unless the distance apart when the search commences is small and the superiority of the speed of the chaser is marked, the average distance may be too great for observation. Again, there are only two points on the meeting curve where the two vessels can meet, whereas every point on the departure curve is a point of possible meeting. Where there are so many possibilities of error it would seem better to steer for some point or points where, if no error is made, the vessels will actually meet, so that the circle of probable error surrounding this point can be estimated and be within the vision of the chaser, than to steer on a line where they will probably pass each other at a distance that may be greatly increased by the probable error. In other words, the probable error is great enough without adding to it an average distance.

Naturally a chasing fleet would steer at an angle to the direction joining its position with the chase, if the course of the chase is known within 180°, so that it would probably be nearer

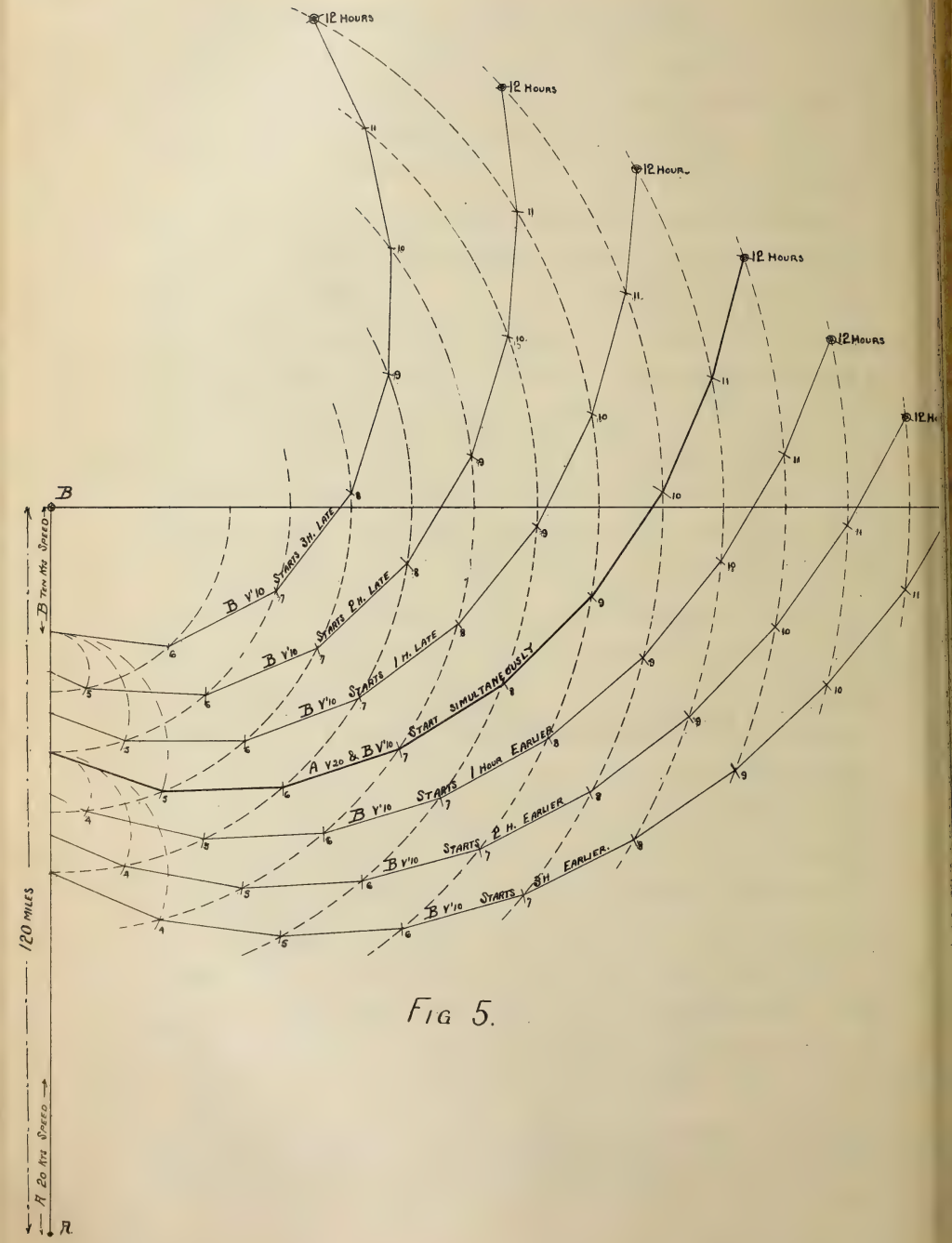

12 HOURS
12 HOURS
12 HOUR
12 HOURS
12 HOURS
B
B TEN MI SPEED
B V'10 STARTS 3H. LATE
B V'10 STARTS 2H. LATE
B V'10 STARTS 1H. LATE
A V20 & B V'10 START SIMULTANEOUSLY
B V'10 STARTS 1 HOUR EARLIER
B V'10 STARTS 2 H. EARLIER
B V'10 STARTS 3H EARLIER.
120 MILES
A 20 MI SPEED
A

FIG 5.

the chase when it (the chase) was discovered by the scouts than if it steered directly toward the first position. The course taken, the speed, and the time of departure of the chasing fleet will be known to its scouts, so that, if they find the chase, they can plot the position of their fleet, and then, by using the meeting curve, can carry the information to the fleet at the earliest practicable moment.

The search curve was attempted in the last English manœuvres and failed. The failure is generally ascribed to foggy weather. The information as to the manœuvres is not sufficiently exact to permit the departure curve, as used, being traced. The Blenheim was at Blacksod Bay, and left there for the rendezvous of her fleet about midnight of the 7th, steaming at the rate of 12 miles. The Powerful and Terrible were north and south of the bay, at distances stated of from 30 to 50 miles, and left in chase of the Blenheim two to four hours later at the rate of 17 miles. If they started just two hours after the Blenheim they would have searched 90° each and met at a point 168 miles to the westward of the bay, having steamed 204 miles each (see Fig. 7, upper curve). If they started four hours afterward they could not have completed the 90° curve in 12 hours. It would have taken about 15 hours, and they would have met at a point 228 miles to the westward of the bay, having steamed about 255 miles. From the various reports it appears probable that the Powerful, being 50 miles north of Blacksod Bay, started on the search at 4 A. M., four hours after the Blenheim left the bay, and continued the search until 7 P. M., and having then completed the search of a 90° sector, without sighting the Blenheim or Terrible, steamed to the rendezvous of her own fleet, which she rejoined about 7 A. M. the following morning. The Terrible, from the south, was unable to keep up her speed of 17 knots and joined her fleet some time after the Powerful. If such were the case, the search for the Blenheim might have failed even in clear weather, as there were too many chances of error during so long a run as that of the Powerful to admit of certainty, and without error the Blenheim might have passed out of the sector searched by the Terrible, ahead of her and out of sight of the Powerful.

By consulting the several departure curves in the various figures it will be seen that uncertainty as to time of the departure of

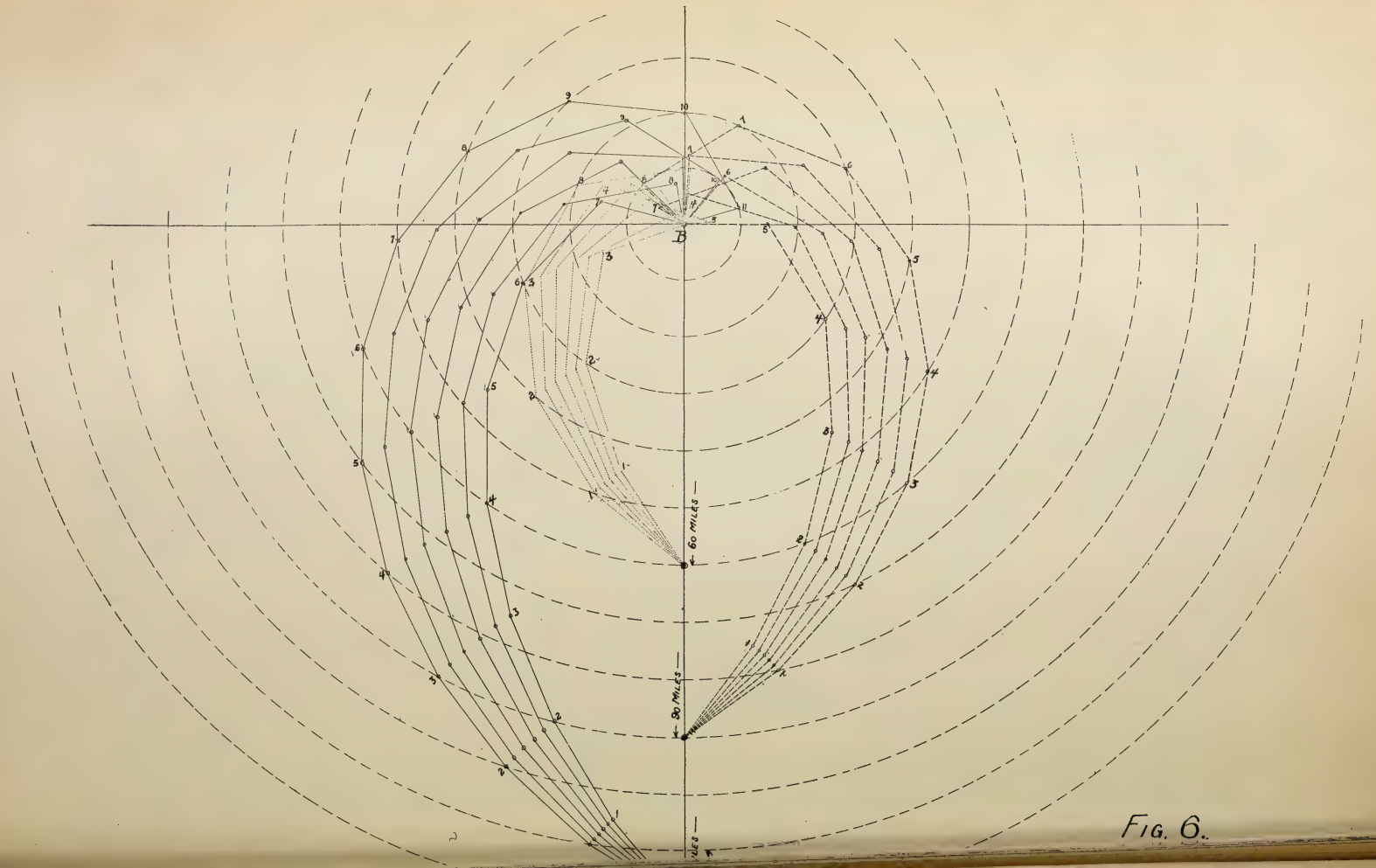


FIG. 6.

the chase will greatly decrease the chances of success of the chaser; and if the sector to be searched is large, more than one vessel must conduct the search and over different curves, the number depending on the amount of the uncertainty. But it would seem as if the time of the departure of the chase would be known within a reasonable degree of accuracy if the fact of her departure was known at all. Of course it must be assumed that the chase proceeds over a straight course, without dodging, otherwise the theory of search falls to the ground and the whole search becomes a matter of guesswork. But the speed of the chase may well be a subject of uncertainty, although it would ordinarily be known within moderate limits. There are two ways by which the search can be made more complete with an additional number of cruisers. One way is to send each chaser over a different curve, assuming different speeds for the chase, and the other to send them all over the same curve at certain intervals apart. The latter method has the advantage of keeping your cruisers in hand, as they can readily reassemble, can be informed if the chase is discovered, and can keep touch as well as send information to the fleet of the discovery; and the accuracy of the search, owing to the intervals being preserved, is fairly uniform, whereas in the first method the intervals between the vessels increase with the length of the search. In chasing over the same curve it must be the curve required by the fastest chase. It is easy to find the number of chasers necessary to make the search reasonably thorough. If the search is to continue 12 hours and the speeds of the chase are to be considered between 12 and 15 knots, the number of vessels required would be four, for the chase can cover 180 miles in 12 hours at 15 knots, and it would take 15 hours at 12 knots, so that to sight the 12-knot vessel and all intermediate speeds a chaser must pass the same spot at 13, 14, and 15 hours after starting. If the search is to continue only 6 hours, four chasers will be sufficient to search for all speeds between 15 and 10 knots, for the chaser will cover 90 miles in 6 hours at 15 knots and it will take 9 hours at 10 knots.

Radial lines have been used more frequently than any other plan of search, except the haphazard method, which is endeared to some because it cannot be accused of being founded upon geometry or any other means by which past human experience is utilized for future benefit.

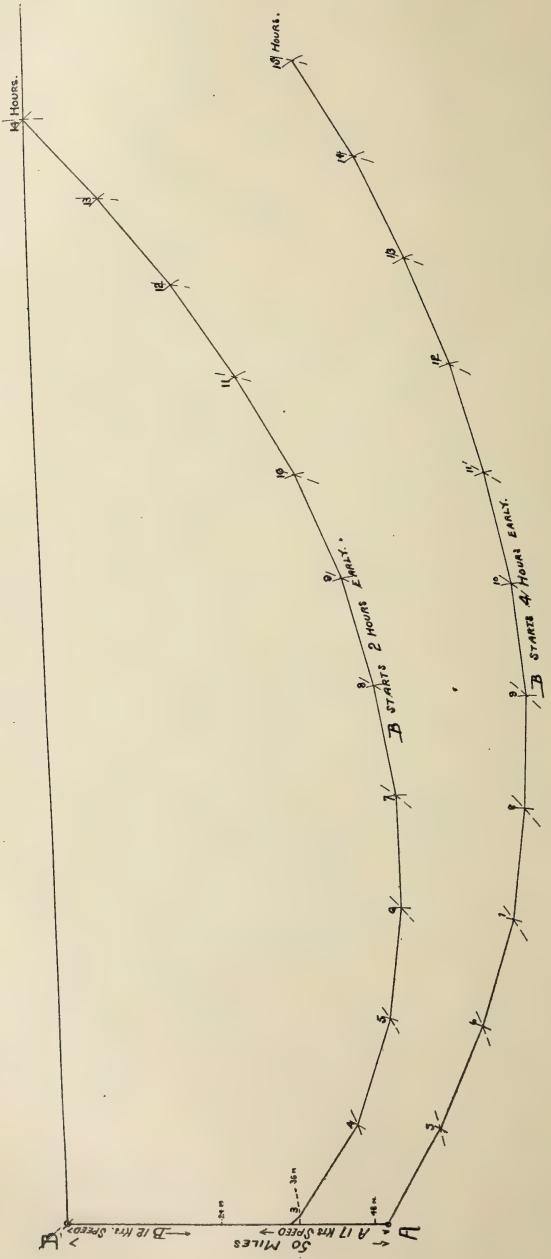

14 Hours.
13
12
11
10
9
8
7
6
5
4
3
2
1
B starts 2 hours early.
10 Hours.
14
13
12
11
10
9
8
7
6
5
4
3
2
1
B starts 4 hours early.
50 Miles
A 17 Mls Speed
B 12 Mls. Speed
A
B

Fig. 7.

Radial lines can be used to advantage when the distance between chase and chaser is small and the difference in speeds is large. This can be readily seen by reference to Fig. 1, with $D = 60$, $V = 20$, $V' = 10$ or less. By radial lines three cruisers could make a close search during daytime and in good weather and complete the search in about 6 hours, gaining 6 hours over the method by departure curve. This is similar to Admiral Marchese's method. But the numbers required to conduct the search by radial lines and the time necessary to complete it increase rapidly with an increase in distance or decrease in difference in speeds. So that, except for extreme cases, radial lines require more chasers and give less chances of success than departure curves.

Many examples of the use of the departure curve could be shown. Fig. 8 illustrates the departure curves drawn for various conditions of time for departure and speed of the enemy with our scouts' speed at 20 knots. In one case information is received by our scouts off Cape Henry that the enemy has left Delaware Bay and is just passing Five Fathom Bank Lightship; in the other our scouts receive the information off Chincoteague that the enemy has left the Chesapeake and is 17 miles to the southward of Cape Henry. In place of scouts our chasers might be a fleet of destroyers, which, if they sighted the enemy in the daytime, might retain touch and strike him at night.

The arrival curve is more limited in its application, and it would be used most frequently by scouts wishing to join the main fleet as early as possible and knowing the general direction from which the fleet is steering at a given speed toward a certain rendezvous. Commandants Z. and H. Montichant, in La Marine Française for December, 1895, give a further example of the use of the search curve, in which they employ four cruisers that proceed to the point of meeting in line, with intervals of 10 miles between cruisers, when the cruiser farthest from the diameter strikes the meeting curve they form column and follow the departure curve. They appear to have failed to account for the time required to deploy 40 miles. With a division already deployed in the right direction this method might prove useful.

To understand the theory or the practice of these curves requires little knowledge of mathematics, and they can be drawn on the chart by any one who has sufficient knowledge to enable

him to plot his course. While in theory they are accurate, the many conditions that may be uncertain will cause the chaser using them to fail frequently in practice. But they offer the best chances of success with the smallest number of ships when used with judgment. The chances of success can be fairly well estimated, and under many circumstances likely to arise in time of war success can be practically assured.

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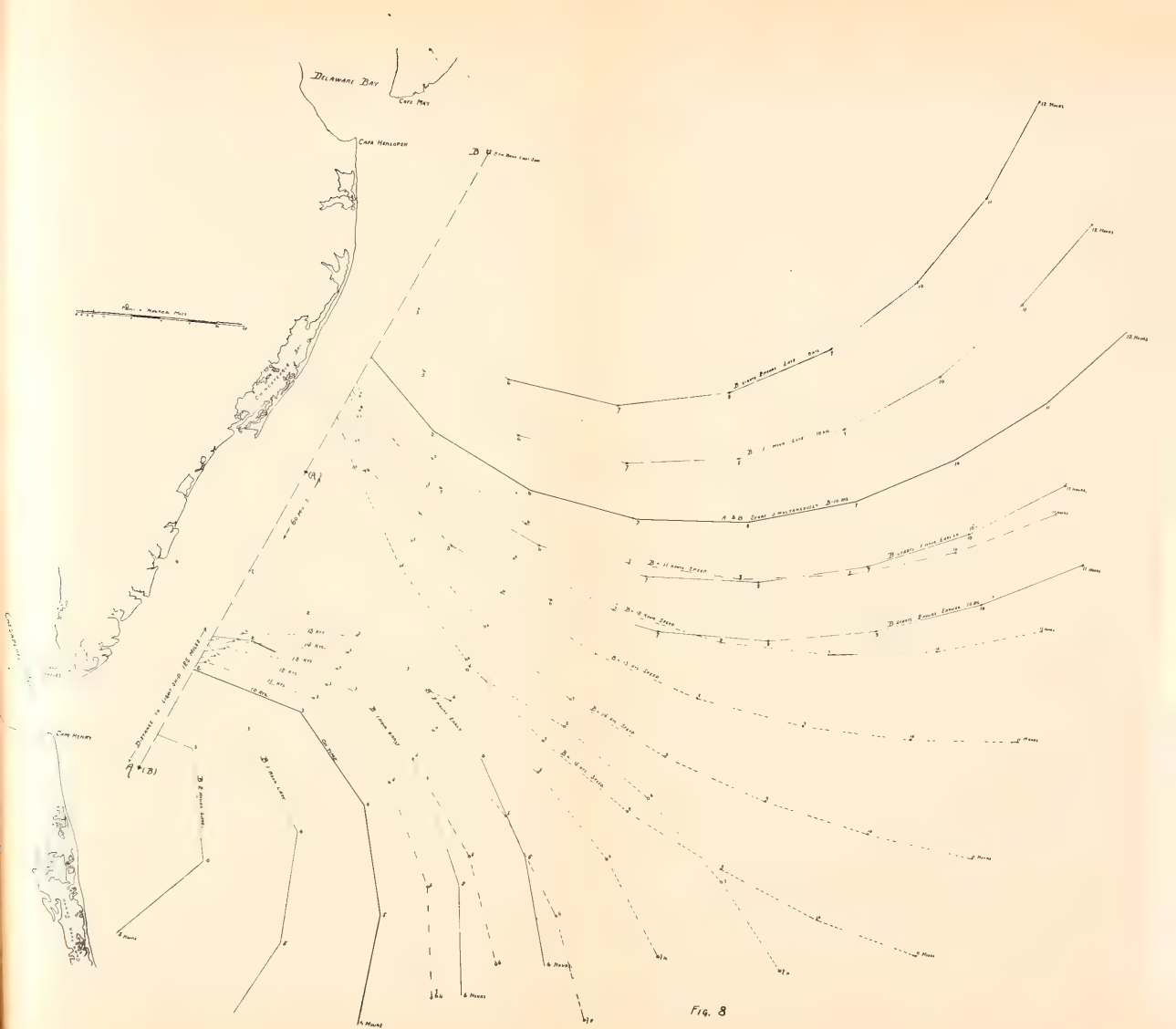
DELAWARE BAY
CAPE MAY
CAPE HENLOPEN
CAPE HENRY
12 Hours
6 Hours
18 Hours
Fig. 8

Fig. 8

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL WAR COLLEGE.

CLOSING ADDRESS, SESSION OF 1897.

By Captain C. F. GOODRICH, U. S. Navy,
President of Naval War College.

Gentlemen:—In accordance with the custom of the College, it becomes my duty to-day to bring the session of 1897 to a close with what may perhaps be not inaptly termed an epilogue. As in the case of a piece performed upon the stage, in the olden time at least, a prologue also was often spoken, either by the author himself or by one of the chief actors in the play. In this prologue were outlined the leading features or the motive of the drama. The unities have been preserved in this instance by the admirable and stirring address of the Assistant Secretary, which has served to toughen our moral sinews and kindle afresh a latent or waning patriotism. The overture to the piece was then introduced. It was, as you may remember, the explanation of the course, largely the work of my predecessor. I served in the main merely as the mouthpiece by which his written words were converted into speech. And now comes the valedictory.

In recalling to mind the explanation of course, I am sure there will recur to you certain distinguishing traits. And it is in contrasting these traits with subsequent developments that we shall be best able to decide as to whether the results of the session have been at all commensurate with the prospect which that address held forth.

The most important characteristic, in my opinion, was its lack of promise. The College distinctly disclaimed the position of teacher, and only claimed that of fellow-student. This stand,

I think, was consistently taken and has been as consistently adhered to. The time may come when, after the College shall have collected and stored and digested and codified a large amount of professional wisdom, it may not improperly pose before the service in a more ambitious light and frankly demand recognition as authority upon the subjects with which it deals; but I am sure that all of you will agree with me that at present its attitude is commendably modest. Furthermore, I take pleasure in acknowledging its indebtedness for many valuable ideas and suggestions, both as to methods and matter, the outcome of your sympathetic labors.

In certain ways, I think the course this year may compare favorably with its predecessors. I could have wished longer time and better opportunity for taking up the subject of International Law in a connected manner, although the facilities of the library in general, and the works of Professor Snow in particular, to which attention has been drawn in the scheme of reading suggested for the officers in attendance, will doubtless have remedied, to a large extent, this unavoidable omission. The questions of International Law which most nearly concern the naval officer are usually those which flow from his responsibilities when in command abroad. To illustrate such points, certain situations, so-called, have been presented for your consideration, and your opinion has been invited as to the course which should be pursued by the officer present in senior command. The situations represent cases which have actually occurred, or those which, under present conditions of international politics, are not unlikely to arise. To analyze such situations and to advance a solution which should represent not only the personal opinion of the writer, but be furthermore justified on the ground of precedent or treaty right, authorities had to be consulted and weighed. Thus you were made familiar with the works which stand highest in professional esteem, and also with the means of using them. In saying this I do not so much depreciate the value of a continuous series of lectures on the general topic, as I seek consolation in the reflection that, under the circumstances, an exceedingly satisfactory substitute was found. It is fitting that I should record and express my deep obligations in many ways to my late colleague, Commander McCalla, to whose ingenuity and judgment these valuable situations are due.

The College has again to congratulate itself upon having enjoyed the privilege of hearing the subject of strategy treated by the gentleman who is recognized throughout the world to-day as the person most competent to speak upon it with authority. Captain Mahan has confided to me his hopes that the naval service will sooner or later furnish him an understudy, in the person of an officer who will take up the questions with which Captain Mahan is so closely identified and which he has made his own. In these days, when it is difficult to discover a special field not already preëmpted and thoroughly tilled, it is encouraging to find that Captain Mahan recognizes the existence of room for men of his own way of thinking, and stands ready to make over to his successor, when he shall appear, such tools as can be passed from hand to hand. It is probable, indeed almost certain, that some one of you here present may, in future years, thank me for this remark leading to the adoption of a professional career full of usefulness, of absorbing interest, and of honor. But he who would follow in Mahan's footsteps must, like Mahan, begin his studies in early youth. Besides this broad treatment of the subject of strategy, you have furthermore been unconsciously imbibing its fundamental notions while studying the history of naval and military operations, as contained in the scheme of reading. In a humble way, the president of the College has pointed out a few of the considerations which seem to him of exceptional weight in determining the strategy of coast defense.

It is necessary from time to time to study and to restudy, even to rediscover, a truth which, perfectly well known at all times, becomes obscured by the passing fancies of the moment, which exercise a dominant power over our faculties. Thus it is with strategy. We are told that its principles are immutable and that these immutable principles are imbedded in naval history, and that if we would rightly apprehend their application we must read not only the history of our own time, but also the history of times far remote. In no other ways can we be permitted to concede the universality of the laws of strategy. Only thus can we fit ourselves for readily apprehending the true course of naval events in the past or for controlling them in the future. I would therefore earnestly urge you all to acquire the habit of reading naval history in a critical and analytical spirit, in order that the true relation of the facts to each other

may appear. I say boldly that strategy is a matter of study, and of study alone. A few of its minor problems may possibly be solved, after a fashion, by utilizing several very large fleets over a somewhat restricted territory. Great Britain notably, and France less satisfactorily, have dealt with certain interesting phases of strategy by means of their naval manœuvers, but where, as with us, the theater of operations is large and the fleets small, the study of strategy must be confined to the shore; the fleet is incapable of dealing with it.

The theoretical discussion of the subject of tactics was less full than usual or than had been planned, owing to the unavoidable absence of certain officers upon whom the College has been accustomed to rely for assistance in the past. I am confident, however, that you have derived much benefit from the tactical games, which have at least taught you some things which a fleet should *not* do, and that you have learned from the tactical situations to weigh well the evidence presented in reports from scouts operating in a theater of war. The proper handling of vessels in groups should become, through practice afloat, a second nature with us. This instruction it is the business of the fleet to impart, but the combined evolutions of a fleet from now till the crack of doom would be barren of result in training the mind to penetrate correctly the plans of an enemy, as revealed in the movements of his detachments. The College alone deals with this matter, so vitally important to success in warfare, and it claims to deal with it in the best manner possible, viz: the manner of Clausewitz and Von Moltke.

The single-ship game has made a distinct step forward, through the introduction of the torpedo as a weapon. Experience and study will improve this as well as the other game, so that they may more nearly represent the conditions of actual warfare. It should be borne in mind, however, that a reasonable approximation is the best we can hope for. This much is undoubtedly true, that he who is expert in manœuvering fleets and ships on the boards of the College will possess a marked advantage afloat, in the more serious game, over his competitor who has been less fortunate in preliminary training.

In the strategic game, fifteen situations have been played during the session. Much interest has been shown and many conclusions of former years have been verified. Valuable sugges-

tions as to changes in the rules of the game have been offered. They will be embodied in the code of rules, if found practicable and expedient.

Naturally, because of the imperfections that must necessarily exist in this mimic warfare, its results can not be accepted in their entirety, but must be analyzed and digested before they can be made the basis of future campaigns.

Certain truths, however, stand out so clearly that we are led to believe, though their importance may be exaggerated by the game, that they exist in the real game of war, as well as in its paper-and-pencil representation.

A great many principles of sea strategy may be deduced from land strategy directly. The strategic game shows most conclusively the necessity of concentrating the fighting force of the fleet. Strong scouting detachments may, and often must be, sent out from the main body, but he who scatters the fighting force (the battle-ships) of the fleet, is vanquished at the outset. The fighting force should be like a spider in the center of his web. The web, the scouts, extending in every direction, but serves to ensnare the foe. The spider, the fleet, should be ready to move instantly, in the direction indicated by the trembling threads, ready to destroy its prey before the slender tissue breaks.

Concentration means strategic life, and dispersion strategic death. Compactness and mobility, too, are essential. Captain Mahan has shown by his analysis of the campaigns of Napoleon in northern Italy that the victories of this great general were due almost entirely to the fact that he kept his forces concentrated, throwing out only small detachments, in order to gain time to move the "central mass," as he styled it, against the enemy's weakest point.

It may be accepted as strategically wrong ever to divide the fighting force into detachments, any one of which is tactically weaker than the enemy's entire force. This fact precludes the dispersion of the ships of the fleet to defend various ports on the coast line, and compels their concentration into a formidable force at the place of greatest strategic value upon the coast.

The strategic game aids us in determining the strategic value at different points. This value of a point depends upon (1) its position, (2) its defensibility, and (3) its resources. The value of position is clearly shown by the strategic game. Its defensibility

belongs to tactics and its resources to logistics. Value due to position is relatively fixed. Man may increase the defensibility and resources of a point, in fact he may almost create these; but he can do little to create or destroy that value of a point which is due to its position. Canals and railroads undoubtedly modify the value derived from position, but this modification is, generally speaking, but slight at most.

It seems to me that this search for points whose position gives them strategic value is the prime object of the strategic game. Next in order comes the study of the means of gaining and transmitting intelligence. An admiral may often fail, though he posts his forces at the best strategic points, if information of his adversary's movements is meagre or tardy.

Having sought out the points of great strategic value by means of the strategic game, we next vary the amount of information that an admiral possesses of his adversary's movements, as well as the rapidity of its transmission. By repeated trials we finally establish the amount necessary to success and also the rapidity with which it must be transmitted. With this desideratum in view, we seek to find the means by which we may gain this necessary amount, and by which it can be transmitted with all possible speed.

The natural conclusion arrived at is that scouts and signal stations cannot be too numerous, too well organized, nor too efficient. Scouting on the sea is more difficult than on land. Fleets, unlike armies, leave little or no trace. The mute waters close behind the vessels and hide their secrets forever.

To insure rapidity of transmission, a perfect network of cables must exist, and a corps of trained operators and signalmen must be organized. Carrier pigeons may play an important rôle in the transmission of information. A system of scouting that will prove infallible is yet to be devised.

Various systems have been tried in the strategic game, but none have as yet proved entirely satisfactory. The process so far has been one of elimination. Scouting by means of a single vessel, and by means of an extended line, the vessels of which are out of signal distance, were inefficient. Scouting by means of vessels in groups of two or three and the use of the French method known as the curve of pursuit have been attended with more or less success. They demand further trial.

The requisites for scouts, as pointed out in the strategic game, are speed, handiness, great coal endurance, and moderate fighting power. These considerations point to the fitting out of the large transatlantic liners for this duty.

On the other hand, the requirements for the vessels of the fighting force exact battle-ships of moderate size, great handiness, small draft, moderate speed and coal endurance, and great fighting power.

Summing up then, the lessons of the strategic game so far are: (1) The necessity for concentrating the fighting force and for keeping it always in communication with the scouts and signal stations. (2) The importance of an extensive and well organized system of scouts and signal stations. (3) The necessity of constant and persevering playing of the games.

Besides being an indispensable means of studying strategy, the strategic game is a most valuable exercise in writing clear, precise orders—orders that, though short, admit of no misinterpretations and provide for all probable contingencies. Great discretion must necessarily be left to the commanders of detached forces, and yet such commanders must be made familiar with the plans and wishes of the commander-in-chief and be able to communicate with him at all times. How often in the strategic games have we seen commanders of scouts at a loss to know what to do, because their orders were not clear or complete, or because the commander-in-chief had changed his plan, on account of some unforeseen contingency, and had made no provision for a change of plan. Nor is this experience confined to our games here. The instance of the false start of the Spanish Armada will suggest itself to your mind. The scattered condition of the fleet was occasioned by lack of knowledge on the part of the captains of Medina's purpose, after the gale which overtook them off Finisterre.

Time is too brief to do more than refer to the obligations under which the College lies to those gentlemen, whether of the Navy or from civil life, who have kindly placed their time and thought and experience at its service. From the lectures they have delivered you have drawn fresh inspiration for labor in the path of duty, and clearer light to make that plain. It must appear to all eminently proper that to one of these addresses I should make particular allusion; I refer to that entitled "A Civilian's

View of the Navy," by Moorfield Storey, Esq. This address will long remain in the minds of those fortunate enough to hear it as a model of lofty motive, scholarly learning, and finished expression. Its earnest appeal for that sincerity and courtesy between nations which mark the intercourse of gentlemen, will not be without influence among those who might be disposed to hold that a nation is absolved through its power from the obligation of scrupulous deference to the rights of other nations. It is idle to claim that no excuse exists for the utterance of these words of caution, in view of certain events not very far remote, in time at least. I am happy to be able to believe that the distinguished lecturer left us with the conviction that the events thus vaguely referred to were not to be taken as indicative of a general spirit throughout the service, that naval officers are not selfish enough to foment international quarrels in order to further their own ends, that among them jingoes are conspicuous by their absence, and that the official designation of this institution is not to be interpreted as implying the preaching of war as an end, but rather as a means to an end, and that end—peace.

Just as it is necessary, from time to time, to rediscover old truths, so must we, now and then, combat and recombat an ever-recurring error. Some heresies die hard. To those who would find fault with the College because of its alleged "unpracticalness," I strongly commend the reading of Captain Mahan's address on that subject, delivered here on September 6, 1892, and printed in No. 66 of the Proceedings of the Naval Institute. He says, "I propose to maintain that, in its common significance, the word *practical* is just as applicable to the processes of thought which precede action as it is to the action which follows thought and reflection; the only difference being that, taking the whole process of thought and action together, the thought which dictates the action is more practical, is of a higher order of practicalness than the resulting action itself." He likens the self-styled practical man, who would, for example, abolish the College and use the fleet without previous and continued study, to the practical man who contemns the preliminary, the paper work of the architect. He adds suggestively, "If you think so—that is, if you think this kind of work unpractical—gather your mechanics and your hod-carriers, provide your material of bricks and mortar, and then, setting to work without your designs and calculations,

rejoice in the evidence of practical efficiency you have displayed to the world."

The wonderful results of the Marengo campaign, which he cites as following upon the patient and prolonged studies of Bonaparte, should in themselves be answer sufficient to the critics who question the thorough practicality of the work done here—unless indeed these gentlemen are in a position to furnish real ships and live men to be destroyed in the cause of the science of naval warfare.

The College has no hesitation in admitting its many sins of omission and commission, while at the same time claiming sincerity of purpose. It looks to those who, like yourselves, have passed through its course, to bring the valuable aid of suggestion and counsel to its management, that the unnecessary or irrelevant (if there be such) may be eliminated, and that important matter or topics at present unrecognized or unappreciated be added in their place. It is largely a new experience which is being tried here. Success will crown our efforts if the aim be useful and worthy, if the efforts employed be earnest and honest, and if those who know both its merits and shortcomings, and are in sympathy with its objects, give it the benefit of the good word, kindly and appositely spoken.

The existence of every university, school, or college in this land lies in the affection and pride of its alumni. The War College is not exempt from this limitation. If you who have spent the past months (far too few and short for our purpose) within its walls leave it with the conviction that you are better equipped for your duty because of the opportunities offered, the future of the College is assured. Its fate rests with you. As you shall speak it, so the service will judge.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

MECHANISM OF MODERN NAVAL WAR.*
NECESSITY OF EXPERIENCE TO EFFICIENCY.

By CHARLES H. CRAMP.

The function of the Naval War College is to teach the art of sea warfare in its larger aspects without reference to the details entering into the sum-total. But the line at which the larger aspects begin to disperse in details, or the details to assemble in the larger aspects, may yet be regarded as subject to much discretion in delimitation.

In drawing such a line the definition of the true relative meaning of the two phrases is of prime importance, and upon the practical correctness of such definition the maximum value of the system of teaching depends. No one will dispute that naval armaments are essential to sea warfare, or that the accomplishment of the objects of the warfare will depend partly upon the character of the armaments, and partly on the wisdom with which their operations are directed; nor can any one gainsay that the wisdom of direction will depend on the conversancy of officers with the nature and necessities of the material units of which the armaments are composed.

These propositions being taken for granted, it becomes clear that there can be no effective system of teaching the art of naval warfare which does not embrace exhaustive study of and consequent close familiarity with the instruments by which the principles of the art are to be carried into force and effect.

From this point of view it must be admitted that questions within the province of the naval architect and problems which

* Address to the United States Naval War College.

he is best qualified to solve, form an essential part of such a curriculum in its largest and most comprehensive aspects.

The unvarying tendency of naval progress is to exalt the importance of the naval architect and to augment the value of the constructor as a factor in the sum-total of sea power.

The naval armament of to-day is a mechanism. If we view it as a single ship it is a mechanical unit whose warlike value depends on its excellence as a fighting machine. If we view it as a fleet, it is an assembly of mechanical units, the warlike value of which will depend alike on the excellence of each unit as a fighting machine, and on the adaptation of each unit to its consorts to produce the most symmetrical efficiency of the group as a whole.

For this reason the word seamanship in the old-fashioned or conventional sense has ceased to cover adequately the requirements of knowledge, skill and aptness which the modern conditions of naval warfare impose upon the officer in command or subordinate.

By this I mean not to depreciate seamanship pure and simple, but to point out that modern conditions require an enlargement of the meaning of the term and a broadening of its scope of function far beyond the exactions of any former period.

In the old days there was no essential difference in ships except in size. Experience in a sloop of war qualified an officer to assume at once and in full efficiency equivalent duties in a frigate, a seventy-four or a three-decker. Familiarity with one ship, irrespective of rate, was familiarity with all ships. Tactical lessons learned in manœuvring one fleet were alike applicable to the manœuvring of all fleets. Even the application of steam as a propulsive auxiliary in its earlier stages did not radically alter the old conditions. At all events it did not practically erase them as the stage of progress at this moment has done.

I cannot better illustrate my point than by comparing the first and the last sea-going battleships built and delivered to the Government by Cramp. The first was the New Ironsides, built in 1862. The last is the Iowa, completed in 1897. Each represented or represents the maximum development of its day.

The New Ironsides had one machine—her main engine, involving two steam cylinders. The Iowa has seventy-one machines, involving one hundred and thirty-seven steam cylinders.

The guns of the New Ironsides were worked, the ammunition hoisted, the ship steered, the engine started and reversed, her boats handled—in short, all functions of fighting and manœuvring—by hand. The ship was lighted by oil lamps, and ventilated, when at all, by natural air currents. Though, as I said, the most advanced type of her day, she differed from her greatest battleship predecessor the old three-decker Pennsylvania only in four inches of iron side armor and auxiliary steam propulsion. She carried fewer guns on fewer decks than the Pennsylvania, but her battery was nevertheless of much greater ballistic power.

In the Iowa it may almost be said that nothing is done by hand except the opening and closing of throttles and pressing of electric buttons. Her guns are loaded, trained and fired, her ammunition hoisted, her turrets turned, her torpedoes—mechanisms of themselves—are tubed and ejected, the ship steered, her boats hoisted out and in, the interior lighted and ventilated, the great searchlights operated, and even orders transmitted from bridge or conning tower to all parts by mechanical appliances.

Surely no more striking view than this of the development of thirty-five years could be afforded.

This growth of complexity and elaboration, and this almost infinite multiplication of parts and devices, have entailed upon the naval architect and constructor demands and difficulties never dreamed of in the earlier days. The staff required to design and construct an Iowa is multiplied in number and the complexity of its organization augmented as compared with that required for the design and construction of the New Ironsides almost infinitely.

Similar conditions apply to command and management. So that while the building of a modern battleship entails enormous work and responsibility on the naval architect, constructor and staff, the effective use of her as a tool in the trade of war presents an equal variety and intricacy of problems to students of the art of naval warfare in this College.

Such questions and such problems cannot be relegated to the category of details. Even if we consider the art of naval warfare in the aspects only of strategy and tactics, both will be affected for better or for worse by the behavior and performance of the units composing the force in operation. This being admitted, it

follows that the behavior and performance of the units will be as the knowledge and capacity of the captains and their staffs; and that no extent of skill and capacity in the admiral directing the whole can overcome or evade the consequences of incapacity and failure on the part of a captain commanding a part.

This is by no means my first discussion of these questions and problems.

In August, 1894, I published in the North American Review a paper on "Sea-power of the United States," some part of which I reproduce here as bearing directly on the matter under consideration. I then said:

Leaving the diplomats and the strategists to pursue their generalizations, I will try to point out the office of the naval architect and shipbuilder in the creation and maintenance of sea power.

Necessarily the employment of battleships for the enforcement of sea power involves their operation in fleets or squadrons.

The experience of war may, and probably will, modify prevailing ideas, and set a limit to the number of battleships that can be safely or effectively manœuvered in squadron. It is more than probable that at an early stage of action the commanding officer of a battleship fleet or squadron will find it necessary to signal for each captain to do the best he can. And it is possible that fleet or squadron tactics, as now received and understood, will be found to impede, if not destroy, the efficiency of modern battleships in action.

No action having occurred between fleets of modern battleships, the tactical conditions must be somewhat conjectural, or at least theoretical; but the experience of peace drills and manœuvers has demonstrated that the elements of difficulty and danger due to modern appliances, as compared with the conditions of the great sea fights of history, have been multiplied manifold.

For example, at Trafalgar, the Victory, Temeraire, and Redoutable were foul of each other for a considerable period. None of these ships of the line sustained any injury worth mentioning from the fouling alone.

I presume no one imagines that three modern battleships could be foul of each other for many minutes before some of them would begin to sink from the effects of contact alone and irrespective of any execution done by their batteries or torpedoes.

This ever present danger is equally great from friend and from foe, and the fact that it must be vastly increased by the circumstances of action will devolve upon the commander of the fleet and upon each one of his captains responsibilities which Rodney and Nelson and their captains never dreamed of.

These facts suggest a wide range of problems, embracing not only tactics, which is outside of my province, but design, structure, manœuvering appliances, in short, everything that pertains to handiness, controllability under various conditions and ultimate safety after a maximum of injury. The fate of the Victoria demonstrated that subdivision into water-tight compartments is useless if communication between any number of them is left free, and that water-tight doors, at least as arranged in that ship, cannot be closed against much head of inrushing water.

Above all, it demonstrated that captains differ in capacity and in promptness, and that such difference operating in the brief time allotted to a single manœuver may easily be fatal to a ship, or, in action, to a fleet. This is a case of the personal equation; the operation of the human factor, which is always unequal to an immeasurable degree if we consider the possible extremes of capacity and incapacity; but at best always subject to error, and hence calculated to defeat or mar in greater or less degree the efficiency of the most skillfully designed and most perfectly constructed mechanical devices. This is a fundamental fact, having its origin in the organic weakness of human nature, and hence unavoidable. At best its consequences can only be mitigated.

In a paper read before the American Society of Naval Architects, November 16, 1893, on "The Evolution of the Atlantic Greyhound," discussing the practicable size of ships, I employed the following language:

> There is another limitation to practicable size which has not been mentioned—the ship may become too large for the captain. It is the fact, that while we may increase the dimensions of ships, the size of man is a fixed quantity. I mean this in the physical as well as the mental sense. A ship is not like an army which can be divided in sections, each capable of independent action. She must be commanded and manœuvered in one piece and by one man.
>
> I have, during many years of observation and experience in my profession, seen so much of the human factor under such circumstances (circumstances placing the lives of many men in a ship at the mercy

of one man) that the elimination of it in every possible direction has become almost a passion with me. In any ship design it is the first principle with me to provide as many absolute and unchangeable qualities of performance and safety as possible, and to place them beyond manipulation.

For the reasons that I have already stated, these observations, originally made with reference to transatlantic passenger vessels, apply with tenfold force to battleships. As the speed of any fleet is that of its slowest ship, so will its manœuvering power be limited by the capacity of its poorest captain. As it might easily happen that the slowest or least handy ship and the poorest captain would be joined, the quality of the other ships and the ability of the other officers would go for nothing.

In view of the complex character of the ships themselves, and the difficulty and danger of manœuvering them under the most favorable conditions, as pointed out, the experience of the first general action will demonstrate the necessity of having all the battleships in a fleet as nearly alike as possible in size, type, and capacity of performance. Such provision would not equalize the personal factor of different commanding officers, but it would at least give them all an equal chance at the start.

For this reason I have always considered it unwise to multiply types or to seriously modify those which the best judgment we are now able to form approves. The practice of the English, French, Russians and Germans has been contrary to this idea. Each new administration of their navies has brought in new types, until their navy lists present an almost bewildering variety.

At that writing (August, 1894) I called attention to the fact that the Mediterranean fleet of England embraced ten first-class battleships, comprising six different types, and ranging in speed from the old Dreadnaught of 12 knots, to the Hood of 16½. Of these six types, four were represented, namely, the Dreadnaught, old-fashioned double turreted monitor; the Sanspareil, sister ship to the late Victoria; the Ramillies, modern barbette battleship, and the Hood, modern double turret battleship. Another type had two representatives, the Nile and Trafalgar, double turret battleships 2000 tons smaller than the Hood; while the sixth type had four representatives, the Anson, Camperdown, Collingwood, and Howe, barbette battleships of the Admiral class, from 3500 to 4500 tons smaller than the Ramillies.

The testimony in the Victoria Court of Inquiry showed not only the difference in the capacity of captains already referred to, but also considerable difference between the several types of ships themselves as to handiness, even at a manœuvering speed of nine knots, which was dictated by the easy natural draught speed of the slowest ship, the Dreadnaught. It is not easy to imagine what the consequences of such discrepancy in the ability and promptness of officers, or in the power and handiness of the different ships, would be under the vastly altered conditions of action.

Of course the English have been accumulating different types during many years of active construction under different and disagreeing Admiralties, and having the ships on hand, must use them, no matter how motley the resulting fleet.

These observations bring us to a survey of the comparative situation of the United States in this respect. Our navy has not accumulated an assortment of battleship types, and hence is free to pursue the desirable policy of uniformity. Our very first attempt at battleship design produced a type which I consider the fairest compromise of all divergent qualities and necessities yet reached anywhere. The resulting ship carries on a displacement of 10,400 tons, armor and armament superior to British ships of 14,150 tons, is equal to them in manœuvering speed, and much quicker and handier under helm.

Our second effort produced a ship which is in some respects a modification of the first. The changes are mainly in the direction of greater freeboard and a knot more of speed, involving 1000 tons more displacement, by which the all-around seagoing efficiency is expected to be increased; but as a fighting ship pure and simple, I think no one contends that the Iowa is an improvement upon the Indiana class. Without going into detail of the differences between the two ships, I will say, generally, that a ship of the Indiana class is able to combat any first-rate battleship afloat as to armor and armament; she has as much speed as will ever be needed for manœuvering purposes, and her coal capacity is sufficient for any cruise that the policy of the United States will ever require in war.

When to these offensive and defensive qualities is added the fact that the Indiana developed on her preliminary trial a readiness of response and fidelity of direction under helm little short

of marvellous, in view of her dimensions and weight, she becomes by great odds the handiest first-rate battleship afloat. In the language of her navigating officer on that occasion, "she steered like a pilot boat." I submit that it does not require the training of a naval tactician to see that a fleet of ten Indianas, compact, handy ships, alike in all leading qualities, would have the ten diverse and unequal battleships of the British Mediterranean fleet at an initial disadvantage of tremendous effect, and this without taking account of individual superiority.

These considerations seem conclusive against multiplication of types, and in favor of adhering to one which so plainly meets the requirements of our national situation and policy.

The composition of a battleship fleet under such conditions would minimize the tactical dangers and difficulties referred to earlier, but they would still remain very great, and nothing can mitigate them except frequent and arduous drill in squadron of evolution, so that our captains may become familiar with their weapons before being called upon to use them in actual battle. There will be scant opportunity to drill a battleship squadron after the outbreak of war.

As already remarked, the views immediately preceding were put forth by me in November, 1893, and August, 1894. It was therefore with very great satisfaction that I read in the London Times report of debate in the Commons on the Naval estimates, March 12, 1897, the following remarks by the Right Honorable George J. Goschen, First Lord of the Admiralty:

> The committee expects some further information with reference to the programme of ship-building which we have placed before them. As the committee knows, that programme includes four battleships, three third-class cruisers, four twin-screw gunboats, and two torpedo-boat destroyers. With regard to the character of the battleships, I will undertake that before these ships are begun the House shall have full information as to their designs, and the opportunity for supplying such information would probably arise on the consideration of Vote 8. But there are reasons why, when we propose to build battleships which are to be commenced some time hence, it is undesirable to pledge ourselves in advance. It is better to have as long an interval as possible, because that gives one the opportunity of watching the development of ship-building elsewhere, which may have some influence and bearing upon our own plans. At the same time I would say generally that we mean to have four powerful battleships and that there are two classes to either of which they might belong. I mean the Majestic class or the Canopus

class. We know at this moment what we intend, but these intentions might be modified, and I trust the committee will not press me to give more information on this subject now (hear, hear). We think it very important that these ships should belong, if possible, to one of the classes which already exist (hear, hear). We have now arrived at a point which to us is very satisfactory. We have got ships which, though criticised to some extent in certain quarters, satisfy public opinion and realize the intentions of their designers, and upon which no serious or large improvements are at present proposed. I believe there is nothing which impresses foreign critics more in connection with our fleet than the fact that we are able in a greater degree than any other country to put into line a number of ships of precisely the same speed and design, forming a thoroughly homogeneous squadron. The advantage of this is felt by all classes of seamen. The men who are passed from one ship to another understand all their duties on the vessel to which they are transferred almost as soon as they get on board. There was an occasion lately when men were transferred from one battleship to another, and within one week every man knew exactly his post, the character of the vessel being familiar to him. I attach great importance to that state of things, and I think that my view is shared by the great majority of the committee.

My object in citing the expressions of the First Lord of the Admiralty is not that of finding support for my conclusions, uttered some time earlier, and which needed no support, but of exhibiting the fact that the experience of the greatest of naval powers has dictated a like policy. In my judgment it is hardly possible to overvalue the importance of homogeneity in fleet organization, and I am sure that the very first, and perhaps the greatest lesson taught by an encounter between fleets of modern battleships will be the advantage of similarity of type and equality of performance in the units of action.

To this element of the art of naval warfare, then, I would invite your most earnest and penetrating attention and study.

Assuming this problem to be satisfactorily solved and the material of the fleet in the most effective possible condition, so far as relation of units to each other and to the sum total is concerned, we have still left for consideration the difference between men; the lack of uniformity in personnel. Homogeneity of material may be attained by adherence to a wise programme of design and construction. But homogeneity of personnel in the sense of uniform capacity and efficiency among individuals is beyond human art or science to produce, because the difference between men is the decree of a higher power. The existence of

this College is itself a devout recognition of that great fact, because its whole objective is to mitigate or minify as much as possible this inherent human frailty by exhausting the resources of training and study, of precept and example.

Illustrations have not been wanting in recent naval manœuvers. The British battleship Resolution was buffeted, half wrecked, and driven into port in distress by a Bay of Biscay storm. Other ships, including at least two of the same type as the Resolution, rode out the storm, not only without disaster, but without effect upon their fighting power; but suppose that had happened in warfare, where the loss of one or more battleships by disability of that nature might turn the scale of odds as between two hostile fleets. From that to defeat, from defeat to loss of sea control, even temporary, and from loss of sea control to invasion, might prove short and easy steps.

There is nothing of record that could be construed as valid reason why the Resolution should have been crippled by the storm which did not affect her exact duplicates. The material was equal, or as nearly equal as likeness of design and similarity of construction could make it. But the performance or the behavior was unequal almost to the point of catastrophe. What then could have been the cause of this inequality? As only two factors were involved, material and personnel, and as the quality of the former was obvious, no cause remains imaginable except that the latter was not equal.

A great battleship, with enormous weights carried high, and massive moveable parts straining at stay-bolts and fastenings with each gyration in the seaway, and all the other vicissitudes of heavy labor under severe storm conditions—all these occurrences operating upon the judgment of a commander not wholly or closely familiar with the capabilities of the ponderous and complex mechanism under his control, might easily shake his faith in the power of the ship to stand it and thereby impel him, as it did the captain of the Resolution, to seek the nearest shelter, regardless of the tactical or strategical schemes or plans which such action might derange.

Clearly in this case the bad performance of a unit of action was due to the commander's lack of familiarity with the operating conditions of the mechanism in his charge. The misfortunes of the Resolution resulted from excessive rolling. The excessive

rolling was caused by failure to accommodate the ship to the wave-action in which she labored. The failure to so accommodate the ship must have been due to want of familiarity with the group of principles in naval architecture upon which calculations of stability and righting moment are based, and upon the proper and successful application of which the safety of ships depends.

Had the commander of the Resolution possessed the rudiments of such knowledge he would have observed the periods and direction of the waves, he would have known the point to which his ship must be laid in order to meet the wave attacks to the best advantage, and his vessel would have undergone no worse punishment than that suffered by the other ships of the same type and model, from whom came no signs of distress.

Had the Resolution been a turret ship, instead of carrying her heavy guns in open barbettes, her difficulty would have been aggravated by the additional high and moveable weights of her turrets. But in no event was she in any danger not instantly and easily surmountable by the simple expedient of laying her course to the point at which the wave action, violent as it was, would be least effective upon the form of her hull.

I do not by any means argue that the commander of a ship should be a naval architect or constructor. But having familiarized himself with principles of that art which touch directly and immediately his function of handling his ship under sea-conditions of common occurrence, and having gained sufficient knowledge of her traits, he should be able to form an instant and correct judgment as to her point of best behavior in any seaway. It goes without saying that sea experience is the only school in which these problems can be worked out.

Knowledge of that character cannot be acquired by study of the experience of others. Close and earnest attention to this source of, at best, partial information cannot serve as a substitute for experience of one's own. At most it can only provide a sound basis on which to take quick advantage of one's own experience when confronted with an actual situation.

This brings me to the suggestion that the modern battleship, with all its complexities, weights and peculiarities of design and model, entails upon commanding officers a new requirement which I can find no better terms to describe than "battleship seamanship." It is a development of the seafaring art which, as

events have proved, is by no means yet mastered in the greatest and most actively exercised navy of the world, therefore it would be too much to expect its mastery in navies of far less magnitude, and hence less means for distribution of opportunities to gain experience.

It therefore follows indisputably that navies of the lesser magnitude should constantly exhaust their means of enabling officers to gain sea-experience by keeping all their large ships in active evolution all the time.

Having thus viewed the modern battleship as a mechanical unit herself, we may profitably pass to brief consideration of the great number and variety of mechanisms composing her. In the strict professional or technical sense these mechanisms concern mainly the engineer and the electrician. But as the foundation of all warlike efficiency in personnel is discipline, and as the foundation of all discipline is the inevitable principle of a single head, one commander, who is to all intents and purposes an absolute monarch, it should follow that "the King can do no wrong."

I have already remarked that the captain need not be a naval architect or constructor to comprehend and be able to apply the group of principles of that art which touch his functions directly in managing his ship as a whole; likewise I would say here, that he need not be engineer or electrician in his relation to the numerous and diverse mechanisms whose proper operation and control are essential to the efficiency of his command.

But, if he really commands, he must know enough about the instruments that do his work to know when they are doing it well and when not; to know whether his subordinates immediately in charge of the several devices are operating them properly or not; to know when defects exist and when they have been made good. If he does not know, or cannot learn these things, he must depend wholly on subordinates immediately in charge, and their reports will be law to him, or if not law, at least decisions from which he has no appeal. Manifestly such a situation is utterly incompatible with the independent and self-relying autocracy which is the essential and fundamental principle of naval command, and without which discipline must sooner or later vanish into mere empty form or conventional myth. These facts, even more than any other considerations, argue for uniformity of type, previously touched upon, so that in learning the traits of

one battleship the officer acquires experience and knowledge applicable at once to the discharge of his duties in another.

I desire here to emphasize a distinction. A man who has successfully commanded a battleship, and has mastered the seamanship which I have described by that title, is qualified to command any other type or class. But it does not follow that a man who has been the successful commander of a cruiser or a gunboat is thereby qualified to command a battleship, because the latter is the graduating point of all seamanship in our time.

From this point of view the captain of the modern battleship finds himself at the parting of two roads as soon as he reads his orders and breaks his pennant. One road is that of taking things easy, relying blindly on subordinates in all the different branches of the ship's economy, accepting trustfully every report that may come to him, starting perhaps at a powder-boy and "respectfully forwarded" up through all intermediate ratings and grades.

The other road is the hard one. I need not describe it *in extenso*, but simply say that it is the road of study, vigilance, inspection, supervision, insight—in short, actual command in the broadest practical sense, in fact as well as in name.

The first road, as I said, is easy, and, if all were fair weather and smooth water, might lead to what would pass for success, if not distinction. But any emergency would end that road in the mire.

The last road is hard to travel, but when it leads into an emergency the captain is found prepared, self-reliant and able to command his subordinates on the spot, instead of waiting to receive their reports. This brings success of the kind that cannot be hid, and with it that valuable and permanent distinction which the public is always ready and anxious to confer upon those who serve it well.

The foregoing discussion is limited to matters affecting the unit of action—the single ship and the captain. Passing to consideration of the unit of operation, the fleet and the admiral, we find another array of problems equally within the scope of this paper.

Let us assume that the composition of the fleet has been made as nearly homogeneous as possible by carrying out the principles previously stated as for ships and their captains, and that the

admiral finds himself in command of an ideal fleet as to material and personnel. Actual differences in efficiency as between the several units of action will still remain, and it will become the first duty of the admiral to ascertain and locate these diversities with unerring judgment and unsparing perception. He should know to a nicety the personal equation of every captain and the effective individuality of every ship.

Among the captains he should be able to differentiate the traits of relative quickness of perception, promptness of action, readiness of responsibility and boldness of execution.

He should know precisely the steering quality of every ship at every speed, which would, of course, include her circle and her time of altering course in any degree, from a fraction of a point to wearing clear around.

In a word, the admiral should have clearly and definitely in his mind a true conception of the coefficient of performance of each unit of his command in all situations, and he should be able at any time and in any emergency to relate these coefficients to each other and to the whole with infallible precision. If it happens that the least competent captain has the least effective ship, and the ablest captain the best ship, the range of coefficients will be wide; if the conditions are reversed, giving to the poorest ship the best captain, and to the best ship the poorest captain, the range of coefficients may be narrowed, but there will always be some diversity, and the tact and skill of the admiral must be measured by his success in reducing the tactical effect of such diversity to a minimum.

It may be suggested that the schedule of requirements just formulated presupposes almost superhuman capacity in the admiral, both as to range of knowledge and accuracy of judgment. If so, I maintain that the command of a fleet of modern battleships, on whose success in a campaign the issue of a cause or the fate of a nation may depend, is of far the greatest and most trying trust that can ever in our time, or in the future, be confided by a people to one man.

Adverting previously to the subject of discipline in the single ship, I pointed out that it could not be attained by blind reliance of the captain on his subordinates. I now suggest that in the fleet the best ends of discipline may not always be subserved, and sometimes may be defeated, by blind obedience of a captain to orders or signals.

In the Victoria inquiry, Rear Admiral Markham stated in substance that it was from the start apparent to him that implicit obedience to Vice Admiral Tryon's apparent order would be impossible without bringing on a collision, that he could not believe that Tryon meant what his signal implied, and after exchange of signals thought that he could not intend to make the manœuver as it was actually attempted. He said he believed, until it was too late to remedy the situation, that Tryon intended to circle round him. Asked by the court why he did not assume the discretion of acting upon his own sense of the situation, Markham replied that the Camperdown could not have altered her course then without violating the rule of the road, which, of course, was as much as saying that he did not see his way clear to disobey an order, even though he knew that obedience must result in disaster. In other words, he preferred to follow the disciplinary traditions of the British Navy at all hazards. (See pp. 52 to 58 of the Report of the Victoria Court Martial, Malta, July 17 to 27, 1893).

The court in its findings expressed "regret that Rear Admiral Markham did not carry out his first intention of semaphoring to the Commander-in-Chief his doubt as to the signal," and then added that "it would be fatal to the best interests of the service to say he was to blame for carrying out the directions of his Commander-in-Chief present in person." (Report, p. 144).

Read between the lines, this two-sided finding would be translated to mean that, while obedience should be the rule, it was by no means the inflexible standard of action.

Perhaps the necessary inference from this historical fact is clear enough without amplification. It is, in brief, that not only should a captain be bold enough to exercise discretion when his judgment on the spot counsels it, but the admiral should be broad enough, not only to tolerate, but to approve such discretion when exercised. Perhaps exercise of discretion in such a case is the most crucial test to which a subordinate can possibly be subjected.

In conclusion it remains only to be said that, valuable as the curriculum of this College may be, it is at best but preparatory. The actual knowledge and the real training which I have shown to be indispensable to warlike efficiency, can be gained by experience afloat, and by that alone.

The dullest intellect now realizes that modern fleets can not be improvised. But some apparently cling still to the illusion that modern seamanship can be. This illusion, if followed, must neutralize all the practical benefit of the new navy this country is building. For any purpose of actual warlike utility our large ships might almost as well not exist as be laid up.

If our navy is to be of use as a public defense, it must be in constant squadron evolution, whether in service on foreign stations or training in home waters.

After all preparatory courses, academic or post-graduate, the one and only ultimate school of efficiency is the deck itself, and that must be the deck of a ship under way.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

No. XXVIII.

By CHARLES E. MUNROE.

The Twentieth Annual Report of Her Majesty's Inspectors of Explosives very properly opens with a resumé of the results of the operation of the Explosives Act of 1875 under which the inspectors hold. The growth of the trade in explosives during this time has been remarkable. Not only has the number of factories increased in the United Kingdom from 55 to 134, but a large proportion of them have been enlarged, some of them having been more than doubled in size. This growth may to some extent be measured by the increase in the number of explosives which may be made in the several factories, or by the number of factories in which each kind of explosive can be made. Thus, while the number of factories in which gunpowder or nitrate mixtures may be made has remained stationary, the number for nitroglycerine compounds has risen from one to nine, and while dynamite was the only nitroglycerine compound produced in 1876, there are no less than twelve such compounds licensed now. The factories for gun-cotton compounds, which include nearly all the smokeless powders, have risen from nine to twenty-nine. The factories for fulminate of mercury have increased from two to six, and for the various kinds of ammunition to about the same extent, while the number of fireworks factories has doubled, notwithstanding the large importations

* As it is proposed to continue these notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications or trade circulars. Address, Columbian University, Washington, D. C.

of Chinese and other oriental fireworks during this interval. The number of magazines has increased from 199 to 288. The comparison for employees is made only for ten years, the number having increased from 7484 in 1885, to 10,023 in 1895. "The number of deaths from accidents by fire or explosion in manufacture was ten only, which, although above the average for the past ten years, marks an extraordinary and most satisfactory contrast with the figures which obtained before the Act came into operation. We repeat that it should also be remembered that not only has the actual number of factories largely increased, but also, in many cases, the amount of output of an individual factory, and consequently the number of hands employed and the resulting chances of accident. Moreover, the risks attending the manufacture of wholly new explosives, to which a large proportion of the new factories are devoted, are less well known than those connected with the more familiar explosives, and, therefore, are not so easy to provide against." The total number of accidents from all causes (excluding non-fatal mining accidents with gunpowder) were 152, causing 40 deaths and injuring 167 persons, while for 1894 the accidents were 102, with 28 killed and 91 injured, and the average for ten years is 132 accidents, with 37 killed and 114.3 injured. The increase in the number reported for 1895 is in a measure due to increased facilities for collecting reports. Only one-fifth of the accidents causing death or personal injury occurred under conditions controlled by the Explosives Act, viz. during manufacture, keeping and conveyance.

It is to be regretted that these reports do not give the amount of the various explosives produced and consumed in Great Britain, as this would be a valuable criterion by which to test the working of the Act.

The complaints that the restrictions imposed by the Act fettered competition with foreign manufacturers, which were freely made in anticipation of the passage of the Act, and which were common in the early days of its administration, have of late years become extremely rare. Other countries have since enacted laws or applied regulations based in no small degree on these, and, as a general rule, of increased stringency. Of these is the Belgian law of October 8, 1894, which appeared in the *Moniteur Belge* of November 8, 1894, and of which

the commissioners themselves say, in submitting the code, "This code is exceedingly severe, but it is rendered imperative by the exigencies of public security," and the German law, which, in many of its regulations, such as the making of cartridges,* goes far beyond what is required in England. The French Committee on Explosive Substances said several years ago of the English Explosives Act: "It appears to the Committee that these wise measures ought to be initiated in France, regard being had to the differences in our institutions and our legislation."

In the operation of the Act during 1895 the following have been added to its list of authorized explosives: Dahmenite A (nitrate of ammonium, naphthalene and bichromate of potassium; the latter not to exceed 2.5 per cent.); Electronite (Nos. 1 and 2) (No. 1 consisting of blasting amberite with carbonate of calcium, and No. 2 of nitrates of ammonium and potassium with wood meal); Emerald Powder (Cooppal's powder colored with the oxalate variety of malachite green); Faversham Powder (nitrate of ammonium with di-nitro-benzol, di-nitro-naphthalene, tri-nitro-naphthalene, chloride of sodium and chloride of ammonium or either of them); Pigou's Military Smokeless Powder (gun-cotton thoroughly purified and gelatinized); Pigou's Sporting Smokeless Powder (nitro-cotton, nitrate of barium and starch colored with indulin); Roburite No. 3 (nitrate of ammonium, di-nitro-benzol and chloro-naphthalene); Rosslyn Smokeless Powder No. 1 (nitro-cotton, nitrates of barium and potassium, or either of them, paraffin or vaseline, and starch), and Rosslyn Blastite (the same ingredients as the preceding, but in a different form), while gunpowder cartridges enclosing sealed tubes containing liquid ammonia have been treated as gunpowder cartridges pure and simple.

Although all nitro-cotton is now admitted to be explosive, and collodion cotton (except when in solution in alcohol and ether, or wet or saturated with methylated spirits and enclosed in air-tight cases) appears on the authorized list; the particular form of collodion cotton used in the manufacture of xylonite and kindred articles may be used under the following easy conditions:

"If the collodion cotton contain not more that 11.11 per cent. nitrogen, then (*a*) if the quantity do not exceed 1000 pounds, no distances need be assigned, but the building to be constructed

* Proc. U. S. Nav. Inst. **22**, 601, 1896.

so far as practicable of uninflammable material, and must be screened from other buildings by a substantial fire-proof screen of such material, construction and dimensions as shall satisfy a Government Inspector; provided that the wall of the building itself, or the wall of any adjoining building, or both walls, may, with the approval of a Government Inspector, be deemed to be such screen; and (*b*) if the quantity exceed 1000 pounds, the distances to be observed from other buildings and works may be half those laid down for the corresponding quantity of gun-cotton, subject to such further reduction, if any, on account of the nature of the ground, intervening mounds, or screens, as in the judgment of a Government Inspector may be properly admitted."

A summary of the reports received on the use of the jelly-bag system of mixing dry cap composition are all in its favor, only four accidents, which were harmless, having occurred with it since 1891, while one company reports having mixed 60 tons of the composition by this means, since 1891, without accident.

Permission to send safety fuze by post was refused on the ground that it might be equally well asked for percussion caps, amorces (properly packed), time fuzes and the like, all of which are classed as explosives, and that it was best to prohibit *all* explosives being sent by mail.

The importation of foreign nitroglycerine compounds for 1895 was—

Blasting gelatine	15,650	pounds.
Carbonite	223,000	"
Dynamite	56,000	"
Gelatine dynamite	493,920	"
Matagnite gelatine	91,500	"
Total	880,070	"

This is an increase on the amount (539,802 pounds) imported in 1894, though it does not reach the average of former years. The dynamite rose from 23,000 pounds in 1894, and the matagnite gelatine has more than doubled. The number of detonators imported in 1895 was 6,981,000, as against 9,765,400 in 1894; while 496,000 pounds (248 tons) of fireworks were imported,

against 290 tons in 1894. A considerable portion of these importations is for re-shipment abroad.

The chemist, Dr. Dupré, reports the examination of 302 different samples, of which all but three (and all of these were fireworks) passed.

The results of the test of one sample of gun-cotton are of special interest. This sample had been manufactured at a time when the pulping of nitrated cotton had not yet been adopted, and must, therefore, have been something like 25 years old. It was contained in a half-pound square tin canister.

The canister was in several places perforated by corrosion, and all the gun-cotton in contact with the metal was stained dark reddish brown. It gave the following results on examination:

Nitro-cellulose, insoluble....	95.46,	heat test, one hour.
" soluble	3.50,	nitrogen, 13.2 per cent.
Mineral matter	1.04	
	100.00	

The mineral matter was chiefly oxide of iron and sulphate of calcium. There was no carbonate of calcium or sodium. The analysis shows that this sample of gun-cotton, probably over 25 years old, is of remarkably good character, and that it has apparently improved, rather than otherwise, as regards the heat test.

Among the alterations permitted in explosives already licensed is the addition of mineral jelly to ballistite.

The *heat test* for gun-cotton and non-gelatinized gun-cotton preparations has been made more stringent by raising the temperature to be employed from 150° to 170° F., the time (10 minutes) remaining as before.

The temperature for the heat test to be applied to all horny or semi-horny explosives consisting mainly of gelatinized gun-cotton (such as Walsrode powder), or gun-cotton and nitroglycerine (such as cordite and ballistite), has been raised to 180° F.

Among the Accidents we note one occurring at Hayle on November 5, during the manufacture of cordite. A cylinder full of the paste had been placed in the squirting press and the pressure just applied, when the cylinder burst and a stream of fire was seen to issue from underneath the press. Through this three of

the six persons present were slightly burned, while 40 pounds of cordite present in the building were set on fire, resulting in the complete destruction of the building. The pieces of the cylinder were not projected with any great violence, and all danger from them could have been prevented by a rope mantlet. The accident is believed to have been due to the heat developed by the too sudden compression of the air in the interstices of the paste, and may be averted by some arrangement for controlling the movement of the plunger.

A similar accident occurred at Waltham Abbey, April 22. The cylinder contained about 30 pounds of cordite paste. About one ounce appears to have exploded, breaking the cylinder in four pieces, and projecting two of them with some violence. The bulk of the paste fell out of the broken cylinder intact, instead of being scattered about, as in the Hayle explosion.

The various explosive accidents reported from the Eley Bros. works, where the wet process for mixing cap composition still prevails, indicates that this method is more liable than the dry process to produce a dangerously sensitive cap. There is undoubtedly a tendency in all chlorate mixtures which have been wet to form minute crystals on the surface and become unduly sensitive in consequence. The wet process may also under certain conditions leave a thin smear of composition on the walls of the cap. Yet there is no doubt that the wet process is free from certain manufacturing risks which it is impossible wholly to eliminate from the dry process.

Among the descriptions of "Foreign Explosions" we especially note those at Leeuwfontein, South Africa, November 28; Butte, Montana, January 15; Pinole, California, May 21; Parkersburg, West Virginia, June 2; and Keeken, Germany, March 19, for their magnitude, the last named being the largest explosion of explosives in transit on record, except that at Santander, November, 1893. Of additional interest is the fact that the explosives at Keeken were frozen at the time of explosion. As much data as possible is given in each case by which to determine the radius of destructive effect.

Several accidents from frozen nitroglycerine explosives are elsewhere recorded in this report.

Among the "Miscellaneous Accidents" are explosions from lignozote (ordinary japan dissolved in benzoline); ether in transit,

by which a freight train was destroyed; and a chlorate of potash lozenge which was rubbed against the igniting surface of a safety-match box in the pocket of a stock broker.

After the usual good-sized list of "Outrages" and "Petroleum Accidents" comes the record of "Experiments," which were devoted to testing the degree of inflammability of magazine clothing when exposed to burning cordite or other nitro-compounds. Many materials were tried, among them lasting cloth jackets and stout woolen cloth trousers, as supplied by the Government, but the most satisfactory in every respect is "white duck" treated with the following solution:

Ammonium sulphate	8 parts.
Ammonium carbonate	2½ "
Boric acid	3 "
Borax	1¾ "
Water	200 "

Dissolve, then add two parts starch, stir well and boil. The fabric should be dry before steeping in this solution.

This most satisfactory report closes with a description of the blowing up of the "Talcen Mawr," a rock which had been immortalized by Welsh bards, and which was estimated to contain from 125,000 to 200,000 tons of matter.

Oscar Guttmann contributes to the *Jour. Soc. Chem. Ind.* **16,** 283–293; 1897, an article entitled "The Chemical Stability of Nitro-Compound Explosives," which discusses the "heat test" as now prescribed, and offers a new one.

The chief "nitro-compound" explosives, nitroglycerine, nitrocellulose or mixtures of these, nitro-benzene, nitro-toluene, picric acid, picrates and the like, are manufactured now-a-days so well that the only possible cause of decomposition is through the action of heat; though sometimes substances are added to them, either to neutralize any free acid present, or to modify the explosive effect, or sometimes they are subjected to mechanical treatment which affects their stability.

Various methods have been proposed to ascertain whether or not an explosive is liable to decompose at the temperatures to which it may be exposed in ordinary storage and use; all of which are based on the detection and the presence of nitrogen

peroxide if it be developed in the explosive. Hess passes the vapors from the heated explosive into a solution of potassium iodide. Some subject the sample to 100°-135° C. for a day or a week, the absence of red fumes being taken as an evidence of stability. Abel's * heat test, using potassium-iodide-starch paper as an indicator, as modified by Dupré,† is used in Great Britain, while in Germany zinc-iodide-starch paper is used.

With proper attention, there is now no difficulty in producing, by Abel's process of pulping and poaching, gun-cotton of sufficiently high stability to pass the English heat test. The practice of adding carbonate of soda, lime, magnesia and the like, is being gradually dispensed with. Guttmann believes himself to have been the first to point out that such addition is not only unnecessary, but a deception, for if real decomposition be going on in an explosive the small quantity of neutralizer added will soon be exhausted, while some of these added bodies have themselves a tendency to decompose some nitro-compounds. That a properly purified explosive will keep practically forever under ordinary circumstances of storage is exemplified by the original sample of nitroglycerine made by Sobrero in 1874, and now stored at the Nobel factory in Avigliana. That the different substances used as neutralizers act differently was shown by Dupré, who found that while practically no effect on the "heat test" resulted from adding calcium or magnesium carbonate to gelatine dynamite, sodium carbonate tended to increase the duration of the test in bad samples and decrease it in good ones. In the bad sample it neutralized the acid already present; in the good sample it tended to decompose it. Guttmann found that ammonium carbonate added to blasting gelatine caused decomposition to such a degree that the gun-cotton partly disappeared and the nitroglycerine sweated out from the cases so that the walls and floor of the magazine were wet with it. The ammonia, which is easily liberated from ammonium carbonate, acts on nitroglycerine, but more readily on gun-cotton.

The nitro-substitution compounds (picric acid, etc.) are easily purified by washing, recrystallization and washing with neutralizers, and are perfectly stable when free from acids.

* Proc. U. S. Nav. Inst. **5**, 11; 1879.
† Proc. U. S. Nav. Inst. **13**, 231; 1884.

Being an oily liquid, nitroglycerine is more difficult to purify, but by the use of compressed air it can be cleansed; sodium carbonate or soda in powder being added to the wash-water to neutralize the bulk of the acid, and the remaining traces being taken out by repeated washings with hot or cold water or very weak soda solution. Besides mixing the nitroglycerine more thoroughly with washing liquids, the compressed air serves to oxidize the lower "nitro-compound" generally present in impure nitroglycerine. Among obscure causes of persistent acidity in nitroglycerine Guttmann found the presence of the spongy lead sulphate, formed in the lead nitrating apparatus, to be one. Being porous, and being especially formed on the line of contact between the air and surface, it absorbs and retains the nitrous impurities, and being detached it falls into and passes off with the nitroglycerine. A minute quantity of this in the sample tested will seriously affect the heat test. Cleansing the "nitrator" corrects this. Another source of error was found due to the method of adding the soda in washing the nitroglycerine. When this is added in powder, instead of in solution, soda mud is thrown down. If some of this mud be placed on litmus paper it gives a distinct alkaline reaction, but if a drop of nitroglycerine be put on top of it and allowed to remain for a while, there will be an acid reaction at the line of contact between the nitroglycerine and the soda mud showing decomposition.

It is not to be assumed that because each of two "nitro-compounds" is stable under the heat test a mixture of them will have equal stability. Blasting gelatine is made by dissolving soluble gun-cotton in nitroglycerine by gentle heating. As some "nitro-compounds" develop nitrogen peroxide at temperatures lower than that of the official "heat test," the stability of the finished product will depend much upon the temperature at which the blasting gelatine is made and the mechanical treatment that it has undergone. The same is true with mixtures of picrates, solutions of gun-cotton in nitro-benzine, and molten masses of "nitro-compounds" of low melting points. In making smokeless powders the paste is made by prolonged treatment in kneading machines, and is frequently rolled into sheets in steam-heated rolls which reduce the duration of the heat test, since treatment at elevated temperatures produces local develop-

ment of nitrogen peroxide, which then develops progressively. In making blasting gelatine the nitrogen contents of or solubility of the gun-cotton in nitroglycerine are not reliable criterions of the ability of the gun-cotton to retain nitroglycerine, as heretofore supposed.

Dynamite may be mechanically unstable through exudation. This depends on the absorptive capacity of the kieselguhr, and the temperature to which the dynamite is subjected. When too low the nitroglycerine freezes, contracts nearly one-tenth its volume, and leaves the outer layer of the absorbent, so that when thawed again it may not distribute itself uniformly through the absorbent. When too high the nitroglycerine expands, and, if the guhr was originally super-saturated, oozes out. Water also, by osmotic action, displaces the nitroglycerine. The possible effect of the heat test on explosives increases with the number of their constituents. Twelve years ago it was found that a good dynamite could not be made with a perfectly good nitroglycerine and an apparently excellent kieselguhr. Examination of the latter showed the presence of considerable amounts of aluminum sulphate, and tests proved that a small quantity of this salt decomposed nitroglycerine.

Several years ago great difficulty was found in transporting gelignite to Australia by sailing ships. It would pass the heat test in England, but fail in Australia and be condemned and destroyed. The cause was found in the wood pulp used in its manufacture. It was essential that it should be dry, and in drying it a part of it was charred, developing acetic acid and methyl alcohol. Guttmann shows that a very small quantity of acetic acid lowers the heat test, though it does not affect the stability of the explosive. When sodium carbonate is present, the methyl alcohol, as a solvent of the "nitro-compounds," accelerates their decomposition.

The smokeless powders gave the Home Office authorities much trouble, which was overcome by requiring for the Schultze class that they be dried in an oven at 120° F. and exposed to the air for two hours before trial by the heat test; and for the cordite class that they be ground in a pug-mill, sifted through a set of thin sieves, and the material retained by the second sieve used for the test.

In September, 1895, Hermann Güttler pointed out that while

he could get a heat test reaction, with iodide paper, from Plastomentite, he could either get none, or only after hours of heating, from Walsrode powder, and that if he put a developed iodide paper in the tube with Walsrode powder, the brown line disappeared almost immediately. Guttmann found, as was to be expected, that this brown line disappeared if the paper was heated for five minutes in an empty test-tube at 180° F., as such discharge of the color is a long and well-known lecture experiment. The German zinc iodide paper proved more sensitive than the English paper. He found that old Walsrode powder gave a much quicker heat reaction than a recently prepared one, and that a large variety of substances are contained in the different smokeless powders which, in his opinion, will stultify the heat test. Foremost among these are acetic ether, acetone and oils, but vaseline, aniline and other substances affect it also. The amount of solvent left in smokeless powder is variable. The greater the density the more difficult it is to drive the solvent off, so that some powders retain as much as one per cent., while others retain but a fraction of a per cent. Though the latter amount may not be apparent to the smell, yet, when the powder is ground and heated in the tube, its presence will be made evident, and if this ingredient be of the class which acts upon iodine, it will tend to make the line on the test paper disappear as the nitrogen oxide given off tends to make it appear. Consequently a powder may be in a state of decomposition and yet the solvent present may prevent the formation of the "brown line" until either the development of the nitrogen oxide has become very great, or a part of the solvent has been driven out by leakages about the stopper or glass rod. This action of acetone and castor oil Guttmann believes explains why he was unable to get a "heat test" reaction with Maxim's powder, even after a two hours' exposure at 90° C., as both these substances were present in the powder.

Besides this, iodide-starch papers made by different chemists gave different results with the same powder. A powder ground in the evening gave a longer "heat test" when tested at once than when tested next morning. Sometimes a powder that was exposed for many months gave a better "heat test" than a freshly prepared one. Coarsely ground powders gave worse "heat tests" than finely ground ones. The mill used for grind-

ing the powders chips the powder, and, though only those grains that are retained by a certain sieve are used for the test, yet there are great differences of size whereby different quantities of the solvent may be given off. From this Guttmann concludes that the iodide heat test, as at present prescribed, is absolutely inapplicable for most of the modern smokeless powders and for some blasting explosives.

As manufacturers may suffer great pecuniary loss through having their products condemned by an unsuitable method of testing, Guttmann sought for a more reliable method, and looking over the various reagents proposed during the last forty years for the detection of small quantities of nitrogen peroxide he tried the following: Griess', a mixture of sulphanilic acid and naphthylamine in acetic acid; Plugge's, mercuric nitrate and carbolic acid; Jorrissen's fuchsine dissolved in glacial acetic acid; Vogel's rosaniline; Medola's para-amido-benzeneazodimethylaniline; Curtman's antipyrine; Kopp's diphenylamine; Frankland's sulphanilic acid and phenol; Griess' *m*-phenylene diamine hydrochloride.

Of these, for reasons given at length, Guttmann selected diphenylamine, and he makes the reagent and test as follows: Place $\frac{1}{10}$ gram of diphenylamine crystals in a wide-neck flask with a ground glass stopper, add 50 cc. of dilute H_2SO_4 (10 cc. H_2SO_4 : 40 cc. H_2O) and place the flask in a water-bath at 50° to 55° C. At this temperature the diphenylamine will melt and at once dissolve in the sulphuric acid, when the flask should be removed from the bath, well shaken and allowed to cool. After cooling, add 50 cc. of Price's double-distilled glycerine, shake well, and keep in the dark. This solution has a strength of about 1 in 1000 by volume.

In making the test 1.5 grams of the explosive, prepared as prescribed in the English tests, is placed in the test-tube heretofore used. Strips of well-washed filter paper, or of any good chemical filter paper, 25 mm. long and 10 mm. wide, are attached to the hooked glass rod as usual and moistened, by applying with a clean glass rod a drop of the diphenylamine solution to the upper corners of the filter paper, so that when the two drops run together about a quarter of the filter paper is moistened. This is now put in the test-tube, which is *now* put in the water-bath, which has been heated to 70° C. The heat test reaction

should not show in less time than fifteen minutes. It will begin with a greenish-yellow color on the moist part of the paper, and from this moment the paper should be carefully watched. After one or two minutes more a dark blue line will suddenly appear on the dividing line between the wet and dry part of the paper, and this is the point that should be taken.

The blue mark appears promptly within a few seconds, while with the iodide paper it takes sometimes as much as two minutes to obtain a well-defined brown line, and even then careful operators often have disputes as to whether the brown line exists or not. The blue mark is not as readily visible by night as by day, but it is still sufficiently clear to be detected. It is better to look at the paper with the light falling on it rather than passing through it from behind. In case of doubt a screen of filter paper behind the tube will make the blue line more readily visible. The incandescent gaslight is the best for observing with; a screen of thin light blue paper being required when the electric or ordinary gaslight is used.

It is essential that the explosive shall contain the least possible moisture, as otherwise the paper will soon become thoroughly wet, when no test can be made. The drying of explosives at temperatures above 40° C. is inadvisable, as at 45° to 50° C. traces of nitrogen peroxide are often developed which would vitiate the test. The present Home Office regulation for drying gun-cotton in an open water-oven at 120° F. is satisfactory, though it might be advisable to dry for one hour instead of fifteen minutes, but at 40° C. only. Smokeless powders should not, as a rule, be dried, as some of the ingredients are, to an extent, volatile at 40° C., while usually they do not contain an appreciable amount of moisture.

Guttmann believes that the coefficient of transmission of heat should not be neglected in these tests, and his experimental data justify his view. In addition he experimentally investigated the relation between the temperature to which a sample is exposed and the time within which the diphenylamine reaction shows itself, and exhibits the results for five bodies in a graphic manner, giving also the formulas by which such curves may be charted. From these he concludes that it will scarcely be sufficient to say that an explosive must withstand a certain temperature for a certain number of minutes to be reasonably safe, for it is pos-

sible to conceive a case where an explosive has a constant approaching zero, and whose decomposition at increased temperatures may require wide intervals of time; while, on the other hand, one may have to wait a rather long time to start decomposition, and yet when once started it may develop rapidly.

Referring to his results, Guttmann says: "Considering that . . . it takes 8½ minutes to heat the contents of a test-tube to 70° C., it may cause surprise that the constant of some powders on the diagram is 5 minutes, and that of gun-cotton 3 minutes only; but this is due to the fact that with them decomposition starts at a lower temperature than 80° C. The heat test value of an explosive will, therefore, be the inferior the more its constant is below the time required for obtaining equilibrium between the outer and inner temperatures of the test-tube, and it will be advisable to fix a minimum limit for the constant of say 5 minutes."

The author does not claim that his method meets all objections to the "heat test." There are still vagaries encountered in its use, and it will still be empirical, but the beneficial effects thus far resulting from the "heat test" prove it to be a necessity.

The paper aroused an extended discussion in which many authorities took part, and which is as valuable as the paper itself. These speakers, as a rule, had not encountered the difficulties in the use of the iodide starch paper that Guttmann had, and Dr. Dupré did not express himself as ready to abandon it for Guttmann's. Mr. Otto Hehner pointed out that while the iodide-starch was a reagent for nitrous compounds, the diphenylamine was a reagent for nitrites or nitrates, the latter of which cannot be detected by the iodide test, and it was therefore obvious that in many cases the two tests could not give the same results because they did not apply to the same thing.

In the *Jour. Am. Chem. Soc.* **19**, 156–170; 1897, E. C. Woodruff gives the results of his study of the "Color Reactions of Nitric and Chloric Acids with Certain Aromatic Bodies," in which he sought to find some new practical tests for nitric and chloric acids, more especially such as would differentiate the two, both in mixtures and separately. The latter object was repeatedly attained. The former was more difficult, because, in general, chloric acid produces a darker color reaction than nitric, in some

few cases sufficiently so as to indicate chlorates in the presence of nitrates; in most cases enough darker to completely mask the nitrate effect; while in some cases the effects were indistinguishable. Still, two methods are given whereby the nitrate effect can be made to predominate, and one that, properly manipulated, accomplishes the desired result very well. The reagent used is dimethylaniline with paratoluidine and sulphuric acid. It gives a colorless solution that keeps well and is an absolute test for nitrates.

The author experimented with a large number of phenols, cresols, oxyacids, amines and so on, and gives his results. Speaking of diphenylamine, he says that "four per cent. gave a light green solution which gradually darkened. This makes a fairly delicate test for nitrates, but there are several serious faults in its workings. First, it gives a rather poorly keeping solution. Second, it will not bear dilution or neutralization. . . . Third, it must be kept cool, as heat alone, even the heat generated by adding a drop of distilled water to two or three of the solution, may give the color supposedly due to a nitrate. Heating changes it first to green, then to a blue, and finally to dense black flakes in a colorless liquid in which water no longer produces a muddy brown precipitate as before."

Under the title "Some Recent Improvements in Smokeless Powder Compounds and in Processes of Manufacture," *Jour. Soc. Chem. Ind.* **16,** 495–499; 1897, Hudson Maxim gives a general review of the composition and properties of smokeless powders, and, speaking of the Maxim-Schüpphaus powders, says a method patented by us for producing a smokeless powder of this character is substantially as follows: Trinitro-cellulose is made into papers or a thin pulp board, which is subjected to a bath made of soluble pyroxyline dissolved in a solvent which is not a solvent of the trinitro-cellulose. In other words, the gun-cotton paper is sized in a collodion bath, which bath may or may not contain nitroglycerine; the excess of the bath being removed, sheets of the material are placed upon one another and pressed together, whereby a body of any desired thickness is built up. The mass is then placed in a suitable die or mold and multi-perforated in a manner explained further on. The hardness and density of the product may be varied within wide

limits by varying the consistency of the bath or the amount of size left in the paper, and also by varying the compression. The material may then be cut into strips approximating in length the powder chamber of the gun, or any length desired. Before being perforated a sheet of unnitrated paper may be affixed to two surfaces of the body, whereby they will be to a great extent protected from ignition during the early stages of combustion in the gun, thus causing a greater degree of combustion to take place within the perforations. Or, the body of material may be multi-perforated and dried, and then coated with any suitable substance which will delay ignition of the surface.

The old black and brown powders being but compressed mechanical mixtures, were unsuited to that special form of grain consistent with the production of the highest ballistic results. With the introduction of smokeless powders, made of a dense and tenacious colloid of gun-cotton, or of gun-cotton and nitroglycerine, it became possible, by a special system of multi-perforations, to produce a grain which will burn in the desired manner, although this result has not been easy of attainment. Trinitro-cellulose requires a large quantity of solvent, not only to dissolve it, but even to render it plastic, and rods or grains formed of it are exceedingly difficult to dry without warping and cracking to pieces, and it is difficult to make it take and retain the exact shape of the forming die. Consequently, unless a very large percentage of nitroglycerine be employed, a composition must be produced which allows working in a much drier state than ever heretofore attempted, in order that the plastic mass shall retain the shape given it by the die in all its geometric details. All this calls for special tools, special processes, and a special compound.

Two smokeless powder compounds are employed by him; one consisting of a compound of nitroglycerine and mixed gun-cottons, the other of mixed gun-cottons without nitroglycerine. The first is made by mixing together in a kneading machine, at a temperature of about 120° F., 80 pounds of trinitrocellulose of about 13.3 per cent. nitrogen, with 8 pounds of gelatine-pyroxyline of 12 per cent. nitrogen (and soluble in nitroglycerine below 100° F.), 12 pounds of nitroglycerine and 35 pounds of pure anhydrous acetone, adding thereto 1 pound of pure urea dissolved in pure methyl alchohol. The mixture is

worked in the kneading machine for about an hour at a temperature of about 120° F., heated by means of a water-bath. The mealy mass is then passed between cold rolls and formed into rough sheets, which are then converted into smooth sheets by passing between slightly warmed rolls. The proper consistency for the mass is easily recognized by the experienced workman by the sense of touch, but the amount of solvent retained may also be easily ascertained by weighing from time to time. Only from 15 to 20 per cent. of solvent should be retained when the compound is ready for stuffing or molding into grains.

The smooth sheets are compactly wound about one another to form a roll of the diameter of the press cylinder, the ends preferably being trimmed. The press is kept warm by means of a water-jacket having a temperature of about 120° F. The press being filled, the cylinder is preferably exhausted of the air within the spaces unfilled by the powder, and the mass pressed hard against the head to solidify it. The forming die is now affixed and the compound forced through it at a pressure of from 3000 to 4000 pounds per square inch, emerging in the shape of multi-perforated cylinders. The smaller the grain the softer should the material be and the higher the pressure required to force it out. The rods are cut into grains about 3 diameters long, placed on shelves in a drying-room, and when partly dried finished in a vacuum.

In the other composition 80 parts of trinitro-cellulose, 19½ parts of gelatin-pyroxyline and ½ per cent. of urea are used. Owing to the absence of nitroglycerine, which facilitates the molding operations, slightly more solvent is left in the material before pressing. It is impossible to evaporate the last trace of solvent from either of the compounds, "but as the quantity remains forever constant, and never escapes, it does no harm."

The peculiar influence of urea is well illustrated by its use in the manufacture of celluloid, such as photographic films, which, in case they are cut from a block of compressed material, and not made by flowing a comparatively thin solution on glass plates, or by an equivalent method, could not be produced without the use of this substance, as the temperature to which it is necessary to subject the material causes such slight decomposition as to discolor the product. Urea counteracts this by neutralizing the nitrous acid as fast as it is formed. Urea has the further

advantage that it is decomposed by nitrous acid into carbon dioxide, water and nitrogen, leaving no solid product behind, while it is not an active alkali and its presence has no effect whatever upon the nitro-compounds with which it is combined.

When soluble pyroxyline is combined with trinitro-cellulose in suitable proportion it has the peculiar effect of rendering the compound plastic and enabling it to be molded with very much less solvent under the influence of an elevated temperature. This effect resembles that produced by camphor combined with celluloid pyroxylin. It furthermore renders the final product more tenacious and less liable to crack.

This is followed by illustrations, with descriptions, of a large number of different forms of perforated grains. No novelty seems to be claimed for them except " a rod or strip of powder having transverse perforations as a new article of manufacture."

In the discussion Mr. McNab observed that Mr. Maxwell Lyte had, about 1868-69, introduced a smokeless powder in France which closely resembled the form described by Mr. Maxim. While Dr. Dupré said that the use of urea was a practice which he had always set his face against, as it was equivalent to, say, adding boric acid to milk to mask a want of cleanliness or of honesty in the milk trade. If a powder were well made it ought to stand without urea or any other masking body. It appeared to him that Mr. Maxim wanted to produce a powder that burnt more rapidly as combustion proceeded. The greater the pressure the more rapid was the combustion, and no peculiar shape of the pellet was needed to ensure this.

In the *Jour. Am. Chem. Soc.* **19,** 388–389; 1897, C. C. Parsons describes a " Method of Drying Sensitive Organic Substances," which he has successfully employed in drying wood-paper pulp in some investigations in nitrating it for a smokeless powder. The process consists in completely immersing a weighed portion of the substance to be dried in about six times its weight of oil in an evaporating dish. The dish containing the oil is placed in a drying closet kept at 240° until the oil has attained this temperature, when it should be weighed and the weighed substance is then immersed in it. There is a slight effervescence during this operation, which is the greater the larger the amount of moisture present. The whole is returned to the closet for a

few minutes and then weighed again, and this is repeated to constant weight. The loss is moisture. The oil prescribed is what is commercially called a straight paraffin oil, free from animal or vegetable oils or fats or foreign mineral substances, perfectly neutral, 0.92 sp. gr. (22.05° B.), 435° flash test, 500° fire test, and about 550° B. P. The object of the high fire test is to ensure the oils being so free from volatile matter that none will be carried off with the moisture of the substance. The oil must be heated in advance, as it absorbs moisture from the air when exposed.

We have noted already the danger of explosion from the contact of sodium peroxide * and combustible agents as proved by Dr. A. Dupré. In the *Jour. Soc. Chem. Ind.* **16,** 492–494; 1897, in "A Note on a Possible Source of Danger of Fire during the Transport of Barium Peroxide," he shows that a mixture of wood-meal and barium peroxide inflames when struck by a two-pound steel weight falling 40 inches upon a steel anvil or by a glancing blow with a wooden broomstick.

Mr. G. E. Barton presents in the *Jour. Am. Chem. Soc.* **19,** 500-509; 1897, an admirable article, "On the Manufacture of Dynamite." In our review of Guttmann's "Manufacture of Explosives," † we have referred to his failure to give the American practice in this manufacture. Mr. Barton's paper supplies this deficiency. It may also be read in connection with description of the Adeer factory referred to below.

William H. Krug and J. E. Blomen give, in the *Jour. Am. Chem. Soc.* **19,** 532–542; 1897, the results of their laboratory experiments on the "Commercial Preparation of Nitro-naphthalenes." The paper opens with some statements regarding the commercial uses of the nitro-naphthalenes which include many instances of proposed use that have never gone into practice. The authors give the results of many experiments made to nitrate naphthalene, and find that it is impossible under the conditions existing to prepare nitro-naphthalenes from *α*-naph-

* Proc. U. S. Nav. Inst. 21, 827.
† Proc. U. S. Nav. Inst. 21, 833, 1895.

thalene-sulphonic acid; that nitro-naphthalenes are best prepared by treating naphthalene with a mixture of sulphuric and nitric acids; that the highest yield is obtained when an excess of sulphuric acid is used; that the degree of nitration, as characterized by the melting point, increases with the amount of sulphuric acid present, though an excess has the opposite effect.

To obtain nitro-naphthalenes for commercial purposes it is best to use nitric acid of 36° B. The amount of sulphuric acid to be used varies with the nitration degree desired, and ranges from 4:1 (nitric: sulphuric) for low melting products, to 3:2 for the higher derivatives. Too large an excess must be avoided, as it chars the product and produces a tarry useless end product. In all cases the product of these processes is a mixture of different nitro-naphthalenes.

"The great Dynamite Factory at Adeer" is the title of a popular illustrated article published by H. J. W. Dam in *McClure's Magazine* **9**, 823–836; Aug., 1897. The article is jauntily written and somewhat misleading, but from it we gather that the works contain 450 separate structures, covering 400 of the 600 acres owned by the Nobel's Explosive Co. at this place; that 200 girls and 1100 men are employed in the factory; that the nitrating charge is 1.5 tons of sulphuric and 1 ton of nitric acid to 700 pounds of glycerine, giving a yield of 1500 pounds of nitroglycerine in 55 minutes running time, the lead convertor with compressed air being used; that all persons entering the "danger area" are rigidly and repeatedly searched, and that all metallic objects—watch, money, penknife, scarfpin, match-case, matches, and keys—are taken from one, while the women are forbidden wearing pins, hairpins, shoe buttons or metal pegs in their shoes or carrying knitting, crochet or other needles; that the employees in the danger area are conspicuously uniformed, nitrators in scarlet, carriers of explosives in dark blue, smokeless powder men in light blue, cartridge girls in dark blue; that the constant absorption of the nitroglycerine stimulates the amorous tendencies of the employees; that magazine shoes of rubber or leather must be worn in every danger house; that the dynamite made here contains about one pound of carbonate of ammonia to twenty-five of kieselguhr and seventy-five of nitro-glycerine; that special magazines are pro-

vided for testing the behavior of the various explosives during exposure for long periods to high and low temperatures; and that thirty thousand tons of dynamite have thus far been transported on English and Continental railways without an accident. The site of the factory, on a barren waste of sand-dunes, stretching for one and three-quarter miles along the sea, was selected by Mr. Nobel in 1871.

Arms and Explosives **5,** 151; 1897, in its report of the annual general meeting of the Nobel-Dynamite Trust Co., Ltd., says that the chairman stated that their trade with Mexico was threatened by the United States factories, and "in order to protect this trade they were considering the advisability of establishing factories both in the east and the west of the United States." The New York *Herald* recently records the purchase of upwards of 600 acres of land in Middlesex county, N. J., for this purpose, where a factory is to be erected which it is expected will give employment to upwards of 1000 men.

Through the courtesy of Lieut. W. R. Quinan we are in receipt of the following interesting "Account of an Explosion" which occurred September 1, 1896, at the California Powder Works, Pinole, California:

"On September 1, about 1.05 p. m., there was a disastrous explosion at these works, resulting in the killing of four white men and eight Chinamen, the destruction of the new nitroglycerine house, the nitroglycerine storehouse, the mixing house, and the usual damage to many other buildings. The nitroglycerine house and storehouse were part of the new works recently built at great expense to the company. Of this plant, the ammonia refrigerating plant and acid cooling house escaped without serious injury. These new works had only been running three days.

"The trouble originated in the nitroglycerine house. Some buckets of nitroglycerine were drawn by the workmen from a waste tank in the basement of this house and brought up to the wash-tank floor and placed on a platform built around the wash-tanks. It was left there a few minutes preparatory to dumping it into the wash-tanks. Water was being drawn into

these tanks for the purpose. While the men were waiting for the tanks to fill—not more than a minute, some of them say—the nitroglycerine in the buckets decomposed spontaneously, but without immediate explosion. There was no other nitroglycerine stored in the house at the time. Two charges were still in the mixers, about ready for discharge. There were four men in the house. The foreman, William Ray, was in charge of the mixers, the other three were below on the wash-tank floor, where they had just been engaged in bringing up the buckets. All the men ran when they saw the evolution of fumes from the buckets. Exactly what took place can only be guessed at in detail, but this seems about the course of events: The decomposition in the buckets was accompanied with a puff, which probably scattered the fuming oil into the scale or weighing tank, thence into the filter tank below, thence it followed a rubber-lined V-gutter to the storehouse 250 feet distant. The switch was still in place in this house, and the decomposition was communicated to the remnant of a charge, probably about 600 pounds, still in one of the store tanks. A stream was running at the time from this tank in a V-gutter or flume to the mixing house, about 1400 feet distant. The decomposition having reached a body of the liquid, an explosion took place, which was transmitted almost instantly to the mixing house, destroying the flume on the way.

"All the men killed were at the mixing house. Three out of the four white men were caught by an unlucky chance. Two were on the 'supply car,' engaged in delivering nitre at the rear. Our track scales being out of order, they were weighing it on a portable scales brought from the warehouse, which made them a quarter of an hour later than usual on that trip. Crater, the foreman of the packing house, had just come to give an order for powder in time to meet his death.

"A few minutes, not more than two at most, after this explosion, the mixers in the nitroglycerine house exploded, destroying everything connected with that building except some sheds covering the outside waste tanks at the foot of the hill. This explosion probably came about in this way: The steam-pipe supplying the engine was broken by the explosion at the storehouse and the machinery was stopped. Fresh glycerine may have run into the mixers from above, or fire may have reached them from the decomposing oil below.

"This explosion differs from most in this: the men who saw the trouble begin lived to tell the tale. This was due to a feature in the new works. As fast as the nitroglycerine was made, purified and filtered, it was run away to the storehouse. If there had been any quantity in the house all the men would probably have been killed and we should have had another mystery with a dozen plausible theories, all of which would have been wrong.

"We have learned a valuable, if disheartening, lesson. It is that the nitroglycerine collected from the waste tanks is much more dangerous than ordinarily believed. The plan of handling it in buckets is the usual one in factories. We were not blind to its dangers, and took precautions not in general use, to purify it to a certain extent before it was drawn from the waste tanks. Its sensitiveness is no doubt due to an excess of impurities derived from the wash-water.

"When the trouble started, the conduit leading from the nitroglycerine to the storehouse was fairly drained. It was about time for the switch in the latter building to be turned. This was a long pivoted trough delivering into a tank of water when out of place. The man on this duty was detained a few moments too long in handling the buckets. If the switch had been broken, there is good reason to think that no serious harm would have resulted from the decomposition in the buckets.

"It is well to note as having a possible bearing on the cause of the trouble, that the quantity of nitroglycerine in the waste tank was unusually large. There were ten buckets of the stuff drawn off and carried up to the wash-tank floor. Nothing unusual was noticed in doing this. One of the men remarked that it was uncommonly clear and free from slums. The quantity was large for this reason: In addition to the usual quantity carried over mechanically from the wash-tanks and a little run down from the second separation, the nitroglycerine collected from the refrigeration of the waste acids at the cooling house was also run down into this tank as well as the wash-waters. This nitroglycerine was regarded with some suspicion, but it was given three careful washings in a lead wash-tank before it was allowed to run down.

"In regard to our waste and catchment tanks, we had a very elaborate system. Besides the one in the basement, from which

the sensitive oil was drawn, we had one at the acid cooling house and two at the foot of the hill below the nitroglycerine house. These escaped, though they had quite a quantity of oil in them. They were all built on the same pattern. Each tank was lead-lined, twelve feet long inside, and drained to one corner. Each tank was divided into four compartments by heavy lead curtains hanging down within a few inches of the bottom. In each compartment there was an air jet to keep the bottom liquid agitated. At the lowest point of the tank a jet of fresh water was introduced to produce a circulation and wash out any acid that might be present. Each tank had an overflow at the end. In regard to the chance of an accumulation of acid in the waste tank, this was rendered impossible. Water was flowing through the tank constantly, and the strong soda from the wash-tanks had to pass through the catchments going down under the partitions in close contact with the bottom liquid which was being stirred by the air-jets. The arrangement was intended to give the waste nitroglycerine a preliminary washing before it was drawn off. That it should have been so prone to decomposition in spite of all the care taken is very strange.

"The simplest view to take of the matter is this: Nitroglycerine, as the immediate product of the nitration of glycerine by mixed acids, is a complex substance. It probably varies considerably in composition from the presence of varying quantities of the lower nitrates and other impurities (some of which are unstable), depending upon the quality of the acids and the glycerine. With these natural and unnatural impurities adhering to it its behavior is very uncertain. Fortunately the impurities are soluble in fresh or alkaline water, and can be removed, leaving a liquid which is fairly stable and well defined in properties.

"The waste nitroglycerine collected in the catchments consists of that carried away mechanically in washing, and also of that precipitated by neutralizing the acid water, as both acid and alkaline waters dissolve more than fresh water or neutral solutions, and this waste nitroglycerine is especially dangerous, because it contains an excess of impurities from contact and mixture with the wash-waters.

"We were using an American glycerine—a brand which up to the time we had regarded as a standard in purity and good

behavior. For obvious reasons I do not mention the name of the manufacturer.

"This explosion had several curious features. An explosion of nitroglycerine proper is free from fire; that, for instance, in the storehouse, a building which had double walls and floors packed with sawdust, though it made match-wood of the building, did not leave a scorched chip behind it. That in the mixers was very different. These were steel vessels with mechanical stirrers. In the short time intervening between the stopping of the stirrers and the explosion the oil had only partially separated from the acids. The explosion was violent enough to destroy the building, but a large portion of the nitroglycerine was an emulsion in the acids and escaped explosion, being scattered with the acids over an immense space. The breeze carried the magnificent yellow cloud toward the north. Grass fires were started in the stubble at a hundred different points within a radius of half a mile. For the first hour or two after the explosion the energies of our men were absorbed in fighting these fires. This was not dangerous work, except in the vicinity of the sheds covering the waste tanks still left standing at the bottom of the hill, near the site of the nitroglycerine house. It was rightly suspected that these tanks contained nitroglycerine (we recovered about 250 pounds from them next day). The fire was burning fiercely near them, and had already attacked the shed covering the last catchment—a small tank about twelve feet beyond the large waste tanks. The flume connecting this with the waste tanks was also on fire. Every few minutes there would be a report like a pistol shot, showing that the fire was coming in contact with small quantities of the liquid. In spite of the danger, some of our men were hastening to the rescue of the waste tanks, when the small tank exploded and did the work for them. The water in the tank was scattered around, and this, with the blast, completely extinguished the stubble, the flume was blown away, and although the large shed was badly wrecked, the waste tanks with their dangerous contents were saved. This is one of the rare instances in which a small explosion prevented a larger and a more serious one."

A profusely illustrated article by Framley Steelcroft in the *Strand Mag.* **73,** 498-506; May, 1897, entitled "Explosives,"

gives brief popular accounts of some among the more extensive explosions which have occurred. Perhaps the most interesting among the pictures given are the photographs of the Johannesburg explosion of February 10, 1896, and that of the great plume of smoke from the Antwerp explosion of September 6, 1889.

General Hawley introduced in the U. S. Senate, May 3, 1897, as S. 1874, 55th Congress, 1st session, a bill entitled "To regulate the importation of gunpowder, nitroglycerine and other explosive substances," which is the same as that given in No. XXVI of these notes.* No further action seems to have been taken than to refer it to the Committee on Commerce.

Mr. Richard J. Friswell, in a paper "On the Properties of Nitro-benzene," *Jour. Chem. Soc.* **71,** 1010–1013; 1897, says that during the severe cold of January, 1886, he obtained crystals from a drum of nitro-benzene which were 2½ inches long, 1 inch broad, ⅜ inch thick, and weighed 15 grams. From such pure material he determined the constants of mononitro-benzene, getting the following: Specific gravity of solid, $d\,\alpha\,\frac{1.5^\circ}{4^\circ} = 1.344$, liquid, $d\,\alpha\,\frac{3.8^\circ}{4^\circ} = 1.222$; $\frac{13^\circ}{4^\circ} = 1.2116$; $\frac{28^\circ}{4^\circ} = 1.1931$. Expansion on fusion, 0.099804. Contraction on solidification, 0.099837. Boiling point at 760 mm., 209° corrected.

Nitro-benzene is remarkable as giving a strongly colored vapor which resembles diluted chloric acid, and is visible in a 2 inch layer, and very marked in a 6 to 8 inch layer.

An editorial of the *Eng. and Mining Jour.* **64,** 242; 1897, on "Magazines for Explosives in Coal Mines," states that "the mining laws of most countries forbid the storage of explosives in magazines directly connected with the underground workings of collieries, though a few countries permit a small supply to be kept in such places. Thus the Austrian regulations permit 100 kilograms, but the magazines must be at least 100 meters from any gallery or shaft through which persons are passing. In Saxony depots to contain 75 kilograms are allowed not less than 50 meters from shafts and 10 meters from galleries, while larger amounts may be stored according to regulations prescribed

* Proc. U. S. Nav. Inst. **21**, 807-815; 1895.

specifically by the mining authorities. According to the French and Belgian laws, only enough explosives for a single day's work may be taken into the mine. Great Britain and many of her colonies have similar laws, and the anthracite and bituminous laws of the State of Pennsylvania are not in this respect essentially different from the more stringent of the European.

"Some of the French colliery managers, however, have desired to go further than the most liberal allowances in other countries, and several years ago made application to the Minister de Travaux for permission to store underground as much as 2000 kilograms of explosives. This application was referred to the Commission du Grisou, and under its direction numerous experiments have been carried out during the past four years to determine to what extent this practice might be safely allowed. M. Ledoux, Ingenieur en chef des Mines, has recently made a report on the subject to the Commission du Grisou, which is published in Vol. XI. of the *Annales des Mines*, 1897.

"The existence underground of large masses of high explosives which are likely to be ignited involves a great number of problems. In the opinion of the French Commission which studied them, the dangers resulting from the invasion into the mine workings of the vast volume of gases of an explosion were most grave. It was conceived, however, that these dangers might be obviated by the interposition of a buffer to work automatically between the magazine and the main gallery of the mine. A system was devised, therefore, whereby in case of explosion a stopper fitting tightly like a piston in the connecting drift would be thrown by an explosion against an annular shoulder, thereby sealing the drift and confining the expanded gases. A series of experiments performed on a small scale proved that this device would work satisfactorily, but the Commission would not endorse it unreservedly until a test on an actual working scale should be made. The interest of the Comité Central des Houllières de France and the Cie. de Blanzy in the matter enabled the Commission to make the desired experiments at Blanzy in December, 1895. A charge of 500 kilograms of 75 per cent. dynamite, enclosed in a gallery of 10 meters length and 5 meters square in section, so that the density of the charging was as 1:100, was exploded. The buffer, cylindrical in shape, was 1.5 meters in diameter and 1.5 meters long. It was built up of two-thirds cardboard and one-third of wood. It was thrown back against

an annular seat .25 meter wide. The chamber was 20 meters below the surface and was approached by an adit 50 meters long. The experiment was successful in every respect. No effect was observable beyond a dull rumbling sound, and no gas apparently was projected into the gallery of access.

"The Commission du Grisou has now laid down the following rules under which large quantities of explosives may be stored underground. Black powder is not permitted; caps cannot be kept in the same magazine with the explosives; boxes of explosives must be opened in a special chamber at least 20 meters from the magazine, and never in the latter. The illumination of the magazine must be exclusively by safety or electric lamps; boxes of explosives must be placed on shelves or benches, and never superposed; the quantity of explosive must be governed by the size of the magazine, so that the density of charge shall not exceed 1:100; good ventilation of the magazine is indispensable.

"The arrangement of the entries of the magazine, position of the magazine with respect to the surface and the working galleries of the mine, and the proper construction of the automatic buffer are described at considerable length; for these details reference should be made to the original paper.

"As to the charge-density, which, according to the commission, should not exceed 1:100, it is necessary to explain that this is worked out from the subjoined formula 1, while 2 gives the pressure produced by the explosion of a given weight of explosive:

$$1. \quad D = \frac{\pi}{V}; \qquad 2. \quad P = \frac{f}{\frac{V}{\pi} - a}.$$

"In these formulae π is the weight of the explosive in kilograms and V the volume of the chamber in liters, while f and a are coefficients depending upon the explosive. Thus in a chamber 5 meters square in section, containing 25 kilograms of dynamite in a box of 0.33 meter long, the volume V is $5.0 \times 0.33 = 1.65$ cubic meters $= 1650$ liters; and the charge-density, according to the formula, is $25 \div 1650 = 0.01515$. If $f = 9.360$ and $a = 0.709$, the pressure of an explosion in this case will not exceed 142 kilograms per square centimeter, while if the charge-density were 1:2 the pressure would be 7250 kilograms. With this disposition the pressure is independent of the quantity of explo-

sive in the magazine. The length of the magazine would be equal to $C \div 75$, in which C is the weight of the explosive, or for 2000 kilograms about 27 meters would be required.

"The position of the powder magazine is an important question, but the arrangements prescribed by the French commission for safety when it is located underground are so elaborate and expensive that it is doubtful if any besides managers of very large collieries will care to adopt them, notwithstanding the obvious advantages that are to be gained from storing explosives in this manner.

"In this connection, however, it is not out of place to refer to the carelessness with which dynamite is often stored underground in metal mines in States of this country where there are no regulations on the subject. There are numerous instances where the magazine is a small chamber opened from a main working gallery, and separated from it by nothing but a light door, not always tight, while within it the explosive is stored and handled with a carelessness that is appalling. That there are not more serious accidents from this source is doubtless because the practice is not very general, and prevails usually only in small mines where seldom more than a small amount of powder is on hand at any one time. There is no excuse, however, for such an accident as that at the Belgian mine at Leadville, Col., in September, 1895, where six men were killed and four more were injured. The supply of powder at this mine, kept in an underground magazine, exploded, the precise cause of the explosion being unknown, and caused a fall of rock which imprisoned the gases of the powder, thereby suffocating six of the gang of men who were at work 100 feet from the magazine."

The exports of explosives from Germany according to U. S. Consular Reports **53,** 253; March, 1897, were as follows:

	1893.		1894.		1895.	
Articles.	Quantity. Double Cent.	Value.	Quantity. Double Cent.	Value.	Quantity. Double Cent.	Value.
Explosives,	22,675	$809,000	40,282	$1,746,000	50,450	$1,809,000
Fuses, powder, etc.	82,123	3,700,000	85,503	3,451,000	92,309	4,165,000

In spite of the closest competition, this year's business will be better than last year's. Sporting powder has hardly held its own, owing to the fact that there is a decrease in the world's demand for this article, yet German sporting cartridges, especially those which are loaded with smokeless powder, are in large demand.

The explosives go in largest quantity to South Africa (to the Cape and Transvaal), and then come, in the order named, Russia, England, Mexico, Chile, Australia, Japan, China, Denmark, and Sweden. The former falling off in sales due to the law forbidding the use of explosives in coal mines is now being made up by the sale of patented (nitro-substitution) explosives, in which the danger from use has been reduced to a minimum.

In the U. S. Consular Reports **52,** 574–576; December, 1896, the price of 75 per cent. dynamite in Cornwall is given as $291.90, and in the west of Scotland $324.97 per ton of 2000 pounds. The price per kilogram (220 pounds) in Hamburg was $68.56 in 1893; $75.32 in 1894, and $61.10 in 1895.

As one of a series of articles on the Witwatersrand gold-field and its workings, Mr. W. Y. Campbell gives in the *Eng. and Mining Jour.* **64,** 190; 1897, an account of the "Mining Explosives in the Transvaal."

"The consumption of explosives in the Transvaal is broadly 200,000 cases per annum. A case is supposed to contain 50 pounds net. The consumption grows daily with the growth of the industry. In the infancy of the gold industry, less than ten years back, a monopoly was granted by the Pretoria government to a shrewd man from Hamburg. The object of the government was incidentally to sell local explosives to the mines, but principally to manufacture locally gunpowder and cartridges for its use and to be independent of imports through British ports. The object of the concessionaire was to make money. The result has been that he has become a millionaire by virtue of his shrewdly worded and shrewdly worked concession, but neither the government nor the industry has ever had a single pound of powder or of dynamite produced locally. At one time the concession was canceled, but a new concession, differently worded, was obtained, and this industry, which has some eleven years to run, embodies a monopoly in the manufacture of explosives and a monopoly of handling and selling.

"At the present time the prices of explosives are as follows:

PRICES, 1896–97.

Trade name.	Nitro glyc. %.	Price per case.	Sales %.
No. 2 dynamite	65	80 s. ($19.20)	.15
No. 1 dynamite	75	85 s. ($20.40)	
Gelignite	80	85 s. ($20.40)	.85
No. 1 A gelatine dynamite	85	98/6 ($23.64)	
Blasting gelatine	100	107/6 ($25.80)	

"These prices are net at depot; freight, and therefore total cost, varies with the distance of consumers from depot. Blasting gelatine forms 60 per cent. of the total consumption.

"The Transvaal is the finest market in the world for mining explosives, therefore, and all the world's manufacturers have been eager to compete, but in vain, as the Nobel group is in possession under the government grant and fixes prices its own way. The mine owners have repeatedly proved that with free trade their explosives would not cost much more than $11.40 a case, against the present average cost of $24.

"The costs per ton mined vary from 25 to 75 cents, while in other parts of the world isolated mines show 10 to 25 cents; 10 cents is the Alaska-Treadwell figure, and that is an isolated mine in remote Alaska. The special levy made by this monopoly on the industry here probably reached a total of $6,250,000 up to the end of 1896. The charge for 1897 will be $2,500,000 more than it would be with free competition, subject only to police and safety regulations.

"The consumption of dynamite, of course, varies per foot driven or sunk, or per ton raised, in the various mines with the various rocks dealt with. The cost of explosives per ton mined varies from 32 to 84 cents in the gold mines, and from 10 to 30 cents in the coal mines; gunpowder for the coal mines and other explosives for gold and coal mines are also barred entry into the State; and scientific advances and improvements in mining explosives are not allowed to benefit these mining ventures, unless the monopolists introduce them.

"The above is the mine owners' view and experience, but the monopolists claim that there is no such thing as 'free trade in mining explosives' outside the United States.

"They say that the Alaska-Treadwell figures are useless, for they are for a low-grade explosive that would not work in the Rand quartzites. They have spent $4,500,000 cash in building a new factory in the Transvaal, and for that risk and expenditure they claim a right to a monopoly. The mine owners retort that they want to buy all mining materials in the best and freest markets, and they are prepared for cancellation of the contract under fair compensation and taking it over as a mines factory on a co-operative system, selling out at cost price. The fight is ten years old and no end in sight. Doubtless, owing to the very intensity of the

economic evil, a remedy will ensue soon; probably the government will buy out the concessionaires and content itself with police supervision of explosives. Then the mines can have a co-operative factory or buy in the cheapest and best markets.

"The following figures of dynamite costs for the year 1896 in one of the best-managed deep-level mines are of interest. During 1896, 833,392 cubic feet of rock were blasted; 64,100 tons of rock were removed, and 10,885 lineal feet of driving and sinking completed. Dynamite cost per cubic foot blasted, 8.8 cents; per ton of rock removed, $1.15; per foot lineal, $6.85. The work done was the development usual in getting at ore and exposing it by levels."

The *Eng. and Mining Jour.* **64,** 244; 1897, says, regarding the "Dynamite Manufacture in British Columbia": "There are three establishments in this province where explosives are manufactured for mining purposes. The Hamilton Powder Company, of Montreal, has works at Northfield, near Nanaimo, and the Giant Powder Company, of San Francisco, Cal., has works at Cadboro Bay, a few miles from Victoria. A third and small plant is making dynamite near Balfour, near the entrance to the west arm of Kootenay Lake. At Victoria sulphuric, nitric and hydrochloric acids are being made by the Victoria Chemical Works, which supply the powder manufacturers."

The important service which the late Alfred Nobel rendered in the development of modern explosives makes it appropriate that a brief mention, at least, of his life and work should be recorded in these Notes. We are indebted to the courtesy of the well-known Ingénieur-Conseil P. F. Chalon for a copy of *Le Temps* of February 18, 1897, which contains a romantic account of Nobel's life, with an attempted analysis of his character, together with much private information. We find also a somewhat extended biography of Nobel, with a portrait of him, in *Arms and Explosives* **5,** 54–55; 1897, while the current press has given much regarding him.

From these sources we gather that Alfred Nobel was born of Swedish parents in Stockholm, October 21, 1833, being the third of four sons. Shortly after Alfred's birth his father moved to St. Petersburg, where he manufactured gunpowder for the

Russian government, invented a torpedo and erected the engineering works which have since become well-known for the small arms and agricultural implements produced in them.

Alfred Nobel was educated as an engineer and chemist, his studies being carried on in Russia, Sweden and England. His linguistic attainments were extensive. He was an omnivorous reader, and took a lively interest in the progress of science, being especially devoted to chemistry and to social science.

He began the commercial manufacture of nitroglycerine in Sweden in 1862. Notwithstanding the extreme hazard attending this enterprise; that his younger brother was killed by an explosion at these works not long after their establishment; that the manager of his newer works at Krümmel, near Hamburg, was killed in 1864; that numerous other disasters occurred; and that, as a result of these accidents, the transportation and use of the explosive were interdicted by law, Nobel persisted in his investigations by which to perfect the processes of manufacture and purification and the methods of transportation and use, and eventually achieved such success that factories for the manufacture of nitroglycerine are now established in all parts of the world and the output has risen from 11 tons per annum in 1867 to over 15,000 tons per annum to-day.

His first patent for "a mixture of ordinary gunpowder with nitroglycerine" was taken out in 1863. He invented "Dynamite," in which the nitroglycerine was absorbed in and retained by a porous solid, like infusorial silica, in 1866. In 1875 he invented "Blasting Gelatine," in which the nitroglycerine is incorporated with soluble gun-cotton to form a plastic, jelly-like mass, and in 1887 he invented "Ballistite," which is formed from the same materials as the preceding one, but in which the soluble gun-cotton is in such large proportions that the product is a solid celluloid-like body which burns, but does not detonate, and which is therefore used as a propellant. With these as bases he formed many mixtures adapted to special purposes.

These, with the discovery of the method of firing by detonation, are the more notable among the many achievements of this daring and resourceful man. There seems to be little record of his writings, but we note "Les explosifs modernes," * which was delivered as a lecture before the Society of Arts, London,

* Paris, Lahure; 1876.

May 21, 1875, and "A bas les armes," which has been translated into several languages.

It is a pleasure to relate that he secured a well-merited reward for his enterprise and application, and that from his inventions in explosives and his association with the firm of Nobel Brothers & Company in the development of the petroleum fields of Russia he accumulated an enormous fortune.

He died December 10, 1896, at his villa at San Remo, and when his will was opened he astonished the world by his munificence and the novel uses to which his bequests were to be put. This is best described in the following extracts from the report of Minister Ferguson, published in U. S. Consular Reports **54,** [201], 330–331; 1897:

"I inclose an extract from the will of Alfred Nobel, dated Paris, November 27, 1895, and which, after disposing of about 2,000,000 kronor in legacies to relatives, servants, etc., directs that the remainder be devoted to the objects set forth in the extract given below. The amount thus devoted to the advancement of science and literature is estimated to be between 30,000,000 and 35,000,000 kronor, and it is thought that it will yield 3 per cent. per annum income, or from $240,000 to $270,000, to be annually distributed in five prizes. Each individual prize will therefore be worth between $48,000 and $55,000.

"Messrs. Ragnar Sohlman, of Bofors, Sweden, and Rudolf Liljequist, of Stockholm, Sweden, who now resides at Bengtsfors, Uddevalla, are named executors. I have written to them for information.

"I understand that several of the heirs at law of Mr. Nobel are contesting the will, and that it may possibly be years before the executors will be able to distribute the prizes."

The extract is as follows:

"My total remaining fortune, when capitalized, shall be disposed of in the following way: When the capital has been converted into good securities by the trustees, it shall form a fund, the interest of which shall be distributed annually as prizes to those persons who shall have rendered humanity the best services during the past year. The interest shall be divided into five equal portions, which shall be distributed as follows: One-fifth to the person having made the most important discovery or invention in the science of physics, one-fifth to the person who has made the most eminent discovery or improvement in chemistry, one-fifth to the one having made the most important discovery with regard to

physiology or medicine, one-fifth to the person who has produced the most distinguished idealistic work of literature, and one-fifth to the person who has worked the most or best for advancing the fraternization of all nations and for abolishing or diminishing the standing armies as well as for the forming or propagation of committees of peace. The prizes for physics and chemistry shall be awarded by the Royal Swedish Academy of Science; that given to works of physiology and medicine by the Carolinska Institute at Stockholm; the prize for literature by the Royal Swedish Academy at Stockholm; and the prize given to the propagators of peace by a committee composed of five members who shall be selected by the Norwegian Storthing. It is my absolute wish that no importance shall be attached to any difference of nationality in awarding the prizes, which, consequently, shall be given to the most competent person, whether Scandinavian or not."

A rather vigorous criticism of the provisions of this will is to be found in *The Spectator*, p. 47, January 9, 1897.

Bruno Thieme, of Sieburg, Germany, has been granted U. S. Patent No. 541,899, of July 2, 1895, for a "Process of making Nitropentaerythrit" for use as an explosive. The claims cover a method of producing a compound for use as an ingredient in explosives, termed nitropentaerythrit, by treatment of pentaerythrit (produced by the condensation of acetaldehyde and formaldehyde in the presence of lime) with concentrated nitric and sulphuric acids.

The reaction given for the formation of the pentaerythrit by the above process is

$$4CH_2O + C_2H_4O + H_2O = C(CH_2OH)_4 + HCOOH,$$

and for the formation of the nitropentaerythrit he gives

$$C(CH_2OH)_4 + 4HNO_3 = C(CH_2NO_3)_4 + 4H_2O.$$

The synthetic method for preparing pentaerythrit is given in *Annalen* **265,** 316.

Pentaerythrit naturally suggests the body known as erythrite (also erythrol, erythro-glucin, phycite and butane tetrol), which is regarded as a tetracid alcohol, having the formula $C_4H_6(OH)_4$. Erythrol occurs free in the *Protococcus vulgaris*, and is found combined with orsellinic acid, as erythrin, in many of the lichens and algae. Erythrol may be obtained from erythrin by saponification with sodium hydroxide or milk of lime. It is readily soluble in water, difficultly soluble in alcohol, and insoluble in

ether. Erythrol possesses a sweet taste, and crystallizes from water in large quadratic crystals.

When dissolved in fuming nitric acid nitroerythrit, or better, erythryl nitrate, crystallizes in brilliant plates which burn with a bright flame and explode like nitroglycerine when struck.

On the further study of "Nitrogen Chloride," W. Hentschel (*Ber. Berl. Chem. Ges.* **30,** 1434–1437; 1897) finds that it is soluble in benzene, chloroform, carbon disulphide and ether; that the substance may be preserved in the solutions for some time in the dark, but that it decomposes rapidly on exposure to a bright light, and that the solvents present so diminish the sensitiveness of the nitrogen chloride that, for instance, a 10 per cent. benzene solution can be ignited or poured upon a red-hot plate without a serious explosion resulting. The solutions are sulphur-yellow, strongly refracting liquids. The solution in benzene is easily obtained by adding ammonium chloride to a 5 per cent. solution of sodium hydroxide which has been treated with chlorine, and agitating the mixture with benzene. About seven-eighths of the active chlorine of the aqueous solution is converted into nitrogen chloride and there is obtained a clear, strongly refractive sulphur-yellow liquid possessing the repulsive odor characteristic of nitrogen chlorides.

The benzene solution, on decomposition by sunlight, gives nitrogen and benzene hexachloride; the carbon disulphide solution gives sulphur chloride; the carbon tetra-chloride gives nitrogen and chlorine; while the chloroform and ether solutions yield ammonia in place of nitrogen, ammonium chloride separating out and hydrogen chloride and chlorine being evolved. The chloroform also yields a trace of hexachlormethane, and the ether a liquid which boils at 80° to 150° and which contains chlorine and reduces silver chloride.

In a paper on "The Naval Weakness of Great Britain," by Sir Charles W. Dilke, *Cassier's Mag.* **12,** 425–440; 1897, after speaking of the necessity of a more complete preparation for war, he says: "In addition to the deficiency in those battleships, the numbers of which are vital to us, there are, as I have said, some points of doubt which are disagreeable to contemplate. The French carry high explosive shells in all their ships, and they

count upon the rapid destruction of the unarmored and of the lightly armored portions of our battleships by means of these shells in an engagement, and believe that the poisonous fumes which the shells emit would render large portions of our armament unusable.

"Our own sailors think high explosive shells unsafe, and the fifty H. E. shells per ship that are now carried by our Channel squadron (and there are none, I believe, carried by any of our other ships) seem to have been taken on board to satisfy public opinion. I am told that the fuses are at the wrong end, so that they are useless for armor piercing, because we have found that we cannot safely use them with the fuses at the right end. The French say that they can so make use of theirs.

"We do not appear to be in possession of shells of the same construction as the French shells, which are carried in the tropics in refrigerating chambers. Our officers generally think our own H. E. shells both useless and dangerous, and probably in time of war would drop them overboard. This is not the case with the French, and, therefore, presumably the French have a safer and better pattern of melinite shell than that which we have been able to supply; and it must be remembered that the French communicate to the Russians the whole of their inventions, and even manufacture, when necessary, for the Russian government.

"French authorities state that melinite is safer than picric acid, and this, which is the basis of a common yellow pigment, is carried everywhere. In the report on the French naval budget for 1897 it is admitted that the French navy and the French army hold different views as to the power of piercing thin steel armor with H. E. shell.

"The navy contend that they can at least explode thin shells within the plate, thus making a big hole, and that all behind will soon lie open and be swept by a fire in the explosions of which no man can breathe."

Through the courtesy of H. M. Inspectors of Explosives, we have been enabled to secure a copy of the second edition of "A Dictionary of Explosives," * by the late Lieut-Col. J. P. Cundill, R. A., which is entirely rearranged and brought up to December,

* London, Eyre & Spottiswoode, 1895, 8vo.

1894, by Capt. J. H. Thomson, R. A. A comparison with the first edition shows that the topics are now arranged in alphabetical order, instead of the inconvenient subdivision into classes of the former edition; that the introductory matter has been increased from 15 up to 44 pages, and the dictionary proper from 108 up to 183 pages, it having at the end a valuable "Index to Ingredients" of explosives. Owing to the misuse which has been made of the former edition, this book can now only be purchased by permit of the Home Office.

The Smokeless Powder Company, Limited, has issued for circulation the lectures delivered by L. G. Duff Grant at the Museum of Practical Geology, October 28 and November 4, 1896, under the title "Smokeless Powder: its appliances, practice and purpose." * The lectures are issued in two parts, the first being devoted to a general survey of explosives and smokeless powders, the second to a description of the works of the company and the results obtained with their product. This second part is quite extensively illustrated. It would appear from the statements on pages 12-14 of Part I that the position of cordite is not yet assured.

"Nitro-Explosives," † by P. Gerald Sanford, is announced as a practical treatise on the properties, manufacture and analysis of nitrated substances, including the fulminates, smokeless powder and celluloid. The book shows that a considerable amount of material has been collected, but the not infrequent "slips" show that he is not practically familiar with the arts about which he writes, while errors in proper names, which are by no means infrequent, show that he has been careless in reading or transcribing. The errors are so frequent as to mislead any but those who are thoroughly conversant with the subjects treated of.

Through the courtesy of Professor Louis Amateis, we are in receipt of "Ascanio Sobrero. Notizie Biografiche," ‡ by Professor Vincenzo Fino. This appears as a reprint from Vol. 31 of the

* London, Smokeless Powder Co. Ltd. No date.
† London, Crosby, Lockwood & Son. 8vo, 270 pp. 43 ill.
‡ Torino, Camilla e Bertolero, 1889, pph. 35 pp. 8vo.

Annals of the Academy of Agriculture of Turin. There is appended a list of the published writings, numbering 123 titles, from which it appears that, in addition to his notable discovery of nitroglycerine and his researches on other explosive nitrates, he gave much attention to mineral analysis, collaborated in research with Avogadro and other eminent chemists, and published a manual on chemistry as applied to the arts, in four volumes. He was born October 12, 1812.

J. B. Baillière et Fils, Paris, announce "Les explosifs et les explosions" au point de vue medico-légal by P. Brouardel, Dean of the Faculty of Medicine of Paris, and "Dynamite et dynamiteurs," Les engines anarchistes, 1894, no author being given.

The eminent bibliographer, Dr. H. Carrington Bolton, has just called our attention to a "Bibliographical Index to the Russian and Foreign Literature of Explosives from 1529 to 1882,"* by A. Heckel. We are able to quote the title only, as the work itself is not accessible to us. It is a curious coincidence that this work should have appeared simultaneously with the annotator's "Index to the Literature of Explosives," and it is to be noted that neither of them is recorded in Guttmann's Bibliography appended to his "Manufacture of Explosives," published in 1895.

Arms and Explosives **5**, 74; 1897, contains an extended review of "A Bibliography of Guns and Shooting,"† by "Wirt Gerrare," in which the work is spoken of in the most approving terms. The main body of the work appears to have been brought up to July, 1894, and an appendix added to bring it up to the end of 1895. The author's name is William Oliver Greener. It is odd that the reviewer should have omitted to give the date of publication, which is presumably 1896 or 1897.

The Neues vom Büchermarkte of the *Mitt. gegen. Artill. u. Genie-Wesens*, page 439, 1896, simply notes "Das Dynamit und seine cultur-historische und technische Bedeutung,"‡ by Nobel.

* St. Petersburg, 1886. † Roxburghe Press. ‡ Wien, 1896.

"A Hand-book of Modern Explosives," * by M. Eissler, is the second edition of a now well-known book first published in 1890. This new edition is enlarged by about one hundred pages and fifty illustrations. The principal additions treat of the testing of the materials for the manufacture of nitroglycerine, the recovery of the spent acids, and the properties of frozen nitroglycerine explosives, while an entire new chapter is devoted to nitrogelatine and gelatine dynamite in their practical applications. It is unfortunate that the book should be marred by errors, and especially that the formulas given for calculating the results of analysis in the tests of acids should be wrong.

* London, Crosby, Lockwood & Son, 1897. 8vo, 406 pp. 153 ill.

DISCUSSION.

Discussion on Consolidated Mess of the Indiana. (See No. 83.)

Commander C. H. Stockton, U. S. Navy.—I am very glad to know that a movement is again under way to reform the present system of messing on board ship. It would be a good thing for the service if matters of this kind would attract more attention, even if it went so far as to deaden the efforts of those man-milliners in the service who devote so much time to the endeavor to change the uniforms of the personnel to the exclusion of more vital matters.

The present system of messes, with incompetent and often broken-down landsmen as cooks, with at times dishonest caterers and with general waste and mismanagement, is a failure, and upon most stations abroad causes our vessels to leave behind a trail of unpaid bills from the men, which is a discredit to the service and a reflection upon our internal organization.

The failure on the part of the men as individuals and messes to meet their bills promptly causes advanced prices on the part of the bumboat men or compradores, and in order to secure the custom of the men it is not unusual on the Asiatic station for a system of advances in cash from the compradores to arise, which causes many individual debts, leads to illicit trading and affects the disciplinary methods of the class system of the ships.

I recognize the consolidated mess as an improvement if it does not rest upon the foundation-stone of the canteen, and provided further if the canteen does not rest upon the foundation-stone of beer. Would the system as presented in the paper under discussion work in small ships and without the canteen?

Apparently every facility has been afforded the consolidated mess of the Indiana for a fair trial, and I have little doubt that if the efforts continue, and if the system of Lieut.-Comr. Delehanty, which I understand does not depend upon the canteen, is also developed and experimented upon, it is most probable that from the two some proper system may be evolved.

There are considerations that must not be ignored, considerations that exist more particularly upon stations other than those of our home waters. One is the necessity for keeping ships in readiness for sudden calls, either for military or other duties. This involves a constant supply on board of certain staple provisions not readily obtained. One of these is hard bread, which is not an article obtainable in foreign markets at a moment's notice. On the Asiatic station bread is not kept on hand as a commercial article, and the least time taken upon that station to have baked good hard bread is one week. A detention of a ship with empty bread rooms, suddenly wanted for distant service, would be a very awkward matter.

I hope any change in mess arrangements will not create any additional yeomen. There are apt to be in most small vessels too many petty officers for the enlisted personnel, and in no instance is there

greater extravagance in this respect than in that of yeomen. The number of yeomen could be reduced one-half without detriment to the service in these vessels.

USE OF ALUMINUM IN NAVAL CONSTRUCTION. (Nos. 82 and 83.)

Professor A. H. SABIN.—My own (unpublished) experiments have shown that rolled aluminum plates have a foliated structure, and while the corroding action of sea water is rather slow on the sides of a plate, it is rapid and penetrating where it acts on the edges. A plate an eighth of an inch thick was not rusted through by immersion in sea water (in a cask) in eight months, but was entirely destroyed to a distance of an inch from the edge, and the edge was swelled up to a thickness of three-eighths of an inch, looking like a bundle of paper. The plate experimented on was pure aluminum and was not exposed to galvanic action. It seems to me that this throws light on the corrosion around bolt-holes and the like; the water gets in, and then it destroys the metal around the edge of the hole. This agrees with the statement on page 530 that the joints swelled and strained the rivets. No doubt the presence of some other metal aggravates the trouble by inducing galvanic action.

It is quite practicable to coat aluminum so as to effectually protect it from sea water. The "pipe coating" described in my paper gives practical protection. The trouble with any coating is that it is liable to be scraped or worn off, and I do not see how this difficulty can ever be avoided. For example, it is of very little use to depend on a coating for protecting the sides of a hatch, because it will be rapidly worn off, while an air pipe or a cowl may probably be kept in good condition for a long time. Even if it gets scratched off in places, these may be retouched by some suitable air-drying varnish; but no coating can ever be depended on for resistance against constant wear. No coating has ever been applied which is of considerable thickness, and in the nature of things it is liable to be worn off and scraped off. I have no confidence in protecting the outside of the bottom of a vessel by any coating if the metal is aluminum; on steel, which is so much less liable to corrosion, it may possibly be of some substantial use. All our experiments show, and I think have fairly proved, that by far the best protection is given by a properly made baked coating; and this is reasonable, for if the material used will stand the heat it is hardened and made more impermeable, while its adhesiveness is not lessened. It is entirely practicable to apply this process to articles of considerable size; it has already been used on pipe sections twenty-five feet long and five feet in diameter, and it can be quite as well applied to even larger objects. It would, of course, be advantageous to get the same results with a coating not needing baking, but it has not yet been done. Some of the varnishes have, however, given very excellent results. If a varnish is used it should be of special quality, and a considerable number of coats should be applied—not less than three, and probably eight or ten would be better. I have no doubt that in this way aluminum may be efficiently protected; but if the coating is scraped off the protection ceases at once.

PROFESSIONAL NOTES.

GROUND GLASS TUBES FOR USE WITH THE NAVIGATIONAL SOUNDING MACHINE. HOW TO MAKE THEM ON BOARD SHIP.

By Lieutenant J. B. Blish, U. S. Navy.

The glass tubes used with the Thompson Navigational Sounding Machine are coated inside with a chemical which changes color when wet with salt water.

After a tube is brought up from the bottom, the distance from the closed end to the line of discoloration shows how much the air within the tube was compressed by the water, and, measured on the scale provided, gives the depth to which the tube was sunk.

Among the disadvantages connected with the use of these tubes are:

(1) Their great cost.

(2) The number of soundings is limited to the supply of tubes.

(3) The supply cannot always be renewed when needed.

(4) The liability to be ruined by salt air or water getting to the coating before using.

(5) The coating sometimes assumes a sort of porous condition that causes the water to discolor the coating above its real height and then indicate too great a depth.

The Bassnett "sounder" and the Thompson "recorder" sometimes used in place of these tubes are:

(1) Very expensive, and therefore ships seldom carry more than two.

(2) They require constant and intelligent care and frequent examination and adjustment.

(3) They are very liable to injury in letting go and in getting them on board again.

(4) They add considerably to the resistance of reeling in, and therefore increase the danger of parting the wire.

(5) They cannot be sent to the bridge for the inspection of the captain, as the glass tubes are on board some ships.

Glass tubes with their inside surfaces ground make perfect substitutes for the Thompson chemical tubes and are free from all the above faults and can be readily made on board.

The principle of these tubes is that *dry* ground glass is translucent—light passes through it, but you cannot see through it; when *wet*, ground glass becomes transparent and looks like plain glass. So the height of the water in the tube is marked by a sharp, clean-cut change from the white *dry* ground glass to the colorless *wet* ground glass. This effect is readily shown by wetting the finger and making a mark with it on an ordinary piece of ground or frosted glass.

Quite a number of these tubes were made on board the U. S. S. Ranger some years ago by the writer, and their use with ship's and boat's sounding machines demonstrated their perfection. They were made as follows:

Two or three wires were taken from a 10-foot length of copper wire rope which had been a lightning conductor. One end of this strand of wires was made fast to a beam overhead and the other rove through the glass tube and held in the left hand. The wires were wet and then covered with powdered glass. The tube was then slid up and down the wires until its inner surface was ground by the powdered glass rubbing against it. If the strand of wires is kept taut the wires lie close together and the tube slides with very little friction; when the strand is slacked up the spring of the wires, caused by the twisting when they were laid up in the rope, forces them out against the inside of the tube and the friction is very much increased. By putting the foot through the bight of the strand, between the tube and the left hand, the friction can be controlled exactly. Not over a dozen motions up and down of the tube (through the distance of a foot or less) are necessary. The wire rope not being at hand, common copper wire can be used to make the strand and a twist given it before the tube is put on.

Powdered emery can be used in place of the powdered glass, but the latter works perfectly and can be made by crushing any kind of glass and sifting it; it ought to be of the fineness of that used by engineers for grinding in valves. Any kind of glass tubing can be used; old Thompson tubes answer perfectly. They must be 24 inches long to make use of the scale provided with the Thompson tubes. This length need not be exact, a quarter-inch or so not making a perceptible difference. After grinding, the tube is washed thoroughly and dried, and will then be white inside.

To put on the cap: The caps used on the Thompson tubes are ordinary percussion caps with the fulminate removed. The end of the tube is dipped in melted ordinary sealing wax and the cap is put on while the wax is hot. Care must be taken that the wax is not too fluid and that the tube is not dipped too deeply, otherwise the wax will extend down in the tube from the end and the readings will be that much too small. It must only cover over the end, not enter the bore.

After these tubes are once used, the salt which adheres to the inside sometimes remains damp and prevents the tube from drying properly. In this case the cap and wax must be removed by holding the end of the tube in a flame, the tube washed out, dried and wrapped. The same process must be gone through with if moisture should collect in the tube while not in use. If the tubes are kept on deck in a tin tube (such as the Thompson tubes come in), with their closed ends up and a half-inch or so of oil in the bottom of the tin tube, they ought to keep ready for use for any length of time.

EFFECTS OF SMALL-CALIBERED RIFLE BULLETS.

All recent reports seem to indicate that the great military nations have gone too far in the reduction of the calibres of their small arms.

French officers who were present at the Dahomey expeditions state that the bullets of the Lebel gun did not stop the advance of the natives.

A number of heavily wounded warriors, shot through and through, advanced up to the very French lines and did not break down until some time after the attack.

Similar reports come from Madagascar. Officers of the marines report that the bullets of the Gras gun, used in the Soudan and at Tonkin, were much more effective than those of the 8-mm. Lebel gun in Madagascar.

In Chitral the English used the Lee-Metford 7.7-mm. rifle, and it was frequently observed that one of the enemy was hit but failed to fall. The natives called the rifle the child's gun, on account of its smallness as well as because they were not afraid of it.

In the battle of Makaland a native was struck by six bullets, in the ankle, about the knee, near the hips, and in the head. The last-named wound was made by a bullet entering the nape of the neck and coming out at the mouth after knocking out several teeth. The wounded man had strength enough left to betake himself to an English field hospital to have his wounds bandaged. He had fully recovered in a very short time after. The surgeons attached to the expedition were able to observe that even very heavy wounds did not cause the falling down of the wounded; they not only continued to march, but even continued fighting for some length of time after they had been hit.

After Jameson's raid in the Transvaal the wounded of both sides were treated in the same hospital at Krügersdorp. The surgeons testified that the wounds caused by small-calibered bullets were very smooth; the very narrow wound of entrance closes of itself, and hemorrhages, the principal cause of weakness in the wounded, were very slight. One of the wounded at Krügersdorp was shot through the lungs, yet after a few days of treatment the wound was healed and the patient discharged. When these things became first known in England there was intense excitement, and many newspapers loudly complained because the Martini guns had been so hastily supplanted by the Lee-Metford rifle.

The Italian Paravicino-Carcano rifle, model 1891, calibre 6.5 mm., sending a bullet of 155 grains weight with a velocity of 2320 feet per second, was named "the rifle which does not kill" by the Abyssinians. The Italian military journals repeatedly hinted at the possibility of the defeat of General Baratieri having been due to the ineffectiveness of the new Italian small-calibered weapon in stopping the rushes of King Menelik's troops, and deplored the absence of the Vetterli rifle. The Italian Colonel Nava, who for some time was a prisoner of the Abyssinians, was able to observe a great number of Abyssinian wounded. He remarked that all wounds not touching vital organs healed with great rapidity, and he came to the conclusion that the new weapon of the Italian infantry was decidedly less deadly than the old one. He also reports that the Abyssinians had given it the name, "the rifle that does not kill." This name gives food for thought, for it is certainly the first time that a weapon of war has been thus characterized. Colonel Nava's reports were corroborated by other witnesses of the effects of bullets of different calibres in this campaign. Comparing the losses of both sides in the battle of Abba Carima, the loss of the Italians was estimated at 14,000 dead and a very few wounded, whereas the Abyssinian loss was 4600 dead and a considerable number of lightly wounded. One witness concludes that the new Italian gun did not impress any fear upon the enemy, whereas the Vetterli and the Gras rifles had inflicted

frightful carnage. A man struck by a bullet from one of these latter weapons receives a heavy shock, is frequently spun around three or four times before falling to the ground.

During the campaign against China the Japanese soldiers were armed with different models of the Murata rifle, one of which, calibre 8 mm., closely resembled in weight and initial velocity the Lebel rifle. An American officer visited the hospitals in Tientsin and reported that the wounds from the bullets of the 8-mm. Murata rifle were characterized by extremely small wounds of entrance and exit, were smooth and healed very rapidly. The opinion of the English surgeon in charge of the wounded was that nine out of ten cases under his charge would have resulted in immediate death had the patients been struck by the ancient lead bullets of 10 or 11 mm.

A military commission in Roumania tested the Männlicher rifle, calibre 6.5 mm., against live horses at a distance of about 1500 yards. Examination of the wounds showed that when the bones or arteries were struck the wounds were very heavy; but when soft parts were struck the wounds were light, and would have been insufficient to stop the rapid advance of the horses, as would be the case in a cavalry attack.

Doctor H. W. Danforth, who has been with the insurgents in Cuba, reporting on the effects of the Mauser bullet, 7.65 mm., states that he saw a man who had been shot through the head fully restored at the end of the year. Another man, Major Osgood of the artillery, lived three hours after he had been shot through the middle of the forehead; had this been an ordinary bullet he would probably have not lived as many seconds. In another case a bullet entered about one-eighth of an inch above the heart and for three hours it was impossible to tell whether or not the heart had been grazed. The man was brought to the hospital, and was discharged at the end of the seventh day. Still another man received a bullet through the thigh bone and wished to remain on horseback for further participation in the fight. The doctor reports having ripped open his trouser leg, and after having applied a plaster around the outer and inner wounds, the man ten minutes later rode in a machete charge. An ordinary bullet would have necessitated amputation of the leg.—*Deutsche Heereszeitung.*

AUTOMATIC FIN-BOATS.

In his fin motors, H. Linden, of Naples, imitates the tail-fins of dolphins, etc., for the purpose of automatically moving a boat against the waves. The boat is fitted with two horizontal fins placed so as to rest on the surface of the water, the one front and the other aft at right angles to the keel. Each fin consists of a steel bar from which flat blades, thicker near the bar, project backwards, resembling a comb with flat teeth. The waves bend the steel blades, which, reacting, press the water backward and therefore the boat forward against the motion of the waves. If both the fins are reversed so as to point forward, the boat moves backward; if one is reversed so that they point towards another, the boat remains stationary. The fins can easily be taken out and fixed in position again, and an ordinary rudder may be used for crossing the waves at an angle. The boat may also be steered by placing the fins obliquely. A boat 14 feet in length requires a total active

fin surface of 10 square feet. Experiments have, according to *Dingler's Journal,* as yet been made with boats only up to 18 feet in length. Larger boats are said to require comparatively less fin surface and to move faster. With a small boat a speed of 5 kilometres, over 3 miles, was obtained on a sea which was stirred up by a strong wind from the south. One application of this new type of boat has already been found. We know that oil smooths the waves; but the oil drifts with the wind, and the remedy is hence of little use to crafts sailing in the teeth of the wind. For the benefit of fishing smacks particularly, Linden has constructed little wooden boats to carry nothing but oil bags. They are taken out in tow and afterwards despatched to quiet the sea around, or to allow the boats to make for the shore. These wooden boats are steered in the simplest possible manner. They need no rudder. The fins are inclined, or the boat is unsymmetrically loaded. If she leans over to the right, she will move to the right. By properly inclining the fins the boat may finally be made to describe a circle. These wooden boats, which are supplied by S. Reitzenbaum, of Berlin, have received the name of "autonauts."—*Engineering.*

LANDING OPERATIONS IN RUSSIA.

This year's landing operations in Russia were eminently successful. On one and the same day, August 25, two landings of troops on an extensive scale were made, viz. at Odessa, the 15th division of infantry, four mounted batteries, two Cossack divisions, a company of marines; and at Sebastopol, three regiments of infantry of the 13th division, four mounted batteries, four companies of sappers and miners, a Cossack division, and a company of marines were embarked in boats and vessels of the Black Sea fleet, besides seven hired vessels.

After 24 hours at sea, and after having by means of feint demonstrations misled the defending land forces (consisting of the 34th division of infantry, with its artillery and the 7th Cossack regiment), the troops were landed in the neighborhood of the little town of Skadarsk. On account of the many horses and wagons, the landing had to be kept up during the night of August 26 to 27, the landed troops having had a successful engagement with the defending corps. During the whole of the 27th constant engagements took place between the two attacking columns and the reserves, which latter were put in the field by the defending corps of the Crimea.

On August 28th the two divisions re-embarked, which operation was not without its difficulties, as it depended entirely upon fleet facilities, and the majority of the vessels, on account of shoal water, were anchored more than three miles off shore.—*Deutsche Heereszeitung.*

SYSTEM OF FOG SIGNALS.

Numerous systems of signals to lessen the dangers of navigation in fog have been suggested. All of them are meritorious from a naval point of view, but they fail in practice. The latest is from Professor E. C. Pickering, director of Harvard College observatory, who presents a method of determining the position of a vessel in a fog based upon the

velocity of sound. If two fog horns of different pitch be placed at equal distances from the middle of a channel or entrance to a harbor, and be sounded simultaneously at regular intervals of about a minute, Professor Pickering says it will be evident that a captain of a vessel will be able to locate his position with a fair accuracy by noting when the sounds of the horns are heard. If the two sounds are heard at the same instant the vessel will be in the middle of the channel, and if they are heard after one another, it would be possible to judge from the interval between the two how much the vessel is out of the middle of the channel. For vessels passing one another, Professor Pickering suggests that each should whistle or blow the horn or siren as soon as the sound is received from the other vessel. Then, if they are five miles apart, each will whistle every fifty seconds, and the distance in miles between the two vessels can always be determined by dividing the intervals in seconds by ten. It is claimed that by placing two different fog whistles on a long steamer, one at the bow and the other at the stern, and arranging that the sounds emitted by both should be heard together by an observer standing at the bow, many collisions might be prevented. Instructions could be given to sailing vessels to keep quiet so long as both signals were heard separately, for they would then be in no danger, but to fire a gun or make other loud noise when both whistles were heard together, for they would then be in front of the steamer. These various methods may be combined indefinitely, according to a circular pertaining to the system, but, says the *Marine Review*, it is probable that the signals will never be given a trial, as they are too complicated, which is the objection to all such systems.—*Engineer.*

TONNAGE OF THE WORLD'S LEADING STEAMSHIP LINES.

Fairplay, of London, publishes an interesting table of statistics, giving the tonnage in actual use by the 16 largest steamship companies of the world. It is compiled from the latest reports of the Bureau Veritas and Lloyd's Register, together with other authorities, and shows at a glance how the great mercantile marine companies compare with each other. According to the statistics thus available, it appears certain that the claim that the Hamburg-American line is the largest shipping company in existence is a just claim, beating, as it does, the largest British company according to tonnage (the Peninsular & Oriental Steam Navigation Company) by 3805 tons gross and 10,154 tons net. The following is the list:

	Companies.	Tonnage. Gross.	Net.
British—			
	P. & O. Steam Navigation Company (London)	283,140	164,836
	British India Steam Navigation Company (London)	251,429	162,482
	T. Wilson, Sons & Co. (Hull)	159,793	103,450
	Pacific Steam Navigation Company (Liverpool)	128,336	77,774
	Cunard Steamship Company, Ltd. (Liverpool)	119,471	65,011
	Ismay, Imrie & Co. White Star Line (Liverpool)	114,290	68,264
German—			
	Hamburg-American Line (Hamburg)	286,945	174,990
	North German Lloyd (Bremen)	265,613	152,126

Companies.	Tonnage. Gross.	Net.
German—		
Hamburg South American Steam Navigation Company (Hamburg)	100,646	65,422
Hansa Steamship Company (Bremen)	84,867	54,446
French—		
Messageries Maritimes Company (Marseilles)	229,837	114,000
Compagnie Générale Transatlantique (Paris)	166,701	72,113
Italian—		
Navigazione Generale Italiana (Rome)	171,041	105,598
Austrian—		
Austrian Lloyd (Trieste)	146,560	87,800
Spanish—		
Compania Transatlantica (Barcelona)	121,161	78,702
Japanese—		
Nippon Yusen Kabushiki Kwaisha (Tokio)	161,698	101,383

—*Iron Age.*

SPEED OF THE ELLIDE.

The 80-ft. yacht Ellide, built for E. B. Warren, vice-president of the Barber Asphalt Co., from the plans of Charles D. Mosher, has made the astonishing record of 37.89 miles per hour. She thus beats the Turbinia's record of 37.7 miles per hour. The Ellide is 80 ft. long over all, 8 ft. 4 in. beam and 3 ft. 6 in. draft. She is of composite construction, with a double mahogany skin, fastened by Tobine bronze bolts, and steel frames and scantlings. Five steel bulkheads divide the hull into six water-tight compartments, and there are in addition a number of copper air-tanks. The motive power is a quadruple expansion engine, with 9, 13, 18 and 24-in. cylinders and 10-in. stroke. The Mosher boiler is practically that used in the new torpedo launches and in the submarine torpedo-boat now building at the Columbian Iron Works, in Baltimore. The speed trial trip mentioned was made on the Hudson River over a mile course measured by the U. S. Coast Survey, and this distance was covered in 1.35 minutes.—*Engineering News.*

RUSSIAN SMOKELESS POWDER.

The new smokeless pyro-collodion powder adopted for the Russian Navy has given the following results at official tests: With the 12-inch gun of 40 calibres, throwing a projectile of 710 lbs., the initial velocity of 2749 feet per second was secured; with the 10-inch gun of 45 calibres the initial velocity was 2697 feet per second; the 4.7-inch gun gave 2598 feet per second with 45-pound projectile; the 3-inch gun gave 2798 feet with the 10¾-pound projectile. With the 6-inch gun and 88-pound projectile an initial velocity of 2880 feet per second was secured. An 8-inch projectile fired from a 45-calibre gun pierced a 10-inch plate of steel with a striking velocity of 2847 feet per second, and after passing through still had a velocity of 700 feet per second.—*Le Yacht.*

TESTS OF ARMOR AND ORDNANCE.

Armor Tests.

[United States.]

A Carnegie armor plate, representing a lot of 500 tons for the 8-inch turrets of the battle-ships Kearsarge and Kentucky, was tested at the Indian Head Proving Ground on the Potomac with excellent results. For testing purposes two 8-inch shells, one a Carpenter projectile and the other a Wheeler-Sterling, were fired at the plate, one at a high and the other at a low velocity. Neither penetrated nor cracked the plate, but partially welded themselves into it. The test was regarded as entirely satisfactory and insures the acceptance of the armor. Subsequent to the test the ordnance officials fired a third projectile at the plate. It was what is known as a capped shell and was fired to show the penetrating power of projectiles of this character. The results were satisfactory, the shell, fired at a high velocity, going entirely through the plate. The delivery of the 500-ton lot of armor will complete the contract which the Government has with the Carnegie Company for the supply of armor for naval vessels. It is not expected that any more contracts for armor will be entered into pending the settlement of the whole armor question by Congress.

Bullet-proof Armor.

A bullet-proof armor, invented by Mr. W. Lennard Foote, of Brooklyn, N. Y., was recently tested, it is stated, with satisfactory results. The character of the material is kept secret, but some of the claims made for it are: That it is 50 per cent lighter than steel plates, having the same resisting qualities; it is non-magnetic, and can be placed around ship compasses where steel cannot; it will not corrode or scale; and when penetrated by bullets it does not splinter, and the bullet hole closes instantly, thus preventing the entrance of water. The test was made by shooting at a block of the material 2½ ins. thick, using a Krag-Jorgensen and a Winchester rifle. In a preliminary test, made to show the penetrating power of these rifles, shots were fired at a column of 24 ½-in. boards placed ½ in. apart. The bullets penetrated all but the two last boards. A shot fired at a ½-in. steel plate bent it badly, and a ¼-in. steel plate was penetrated. The test shots failed to penetrate the special armor, and were found embedded in it, with the entering hole entirely closed. A plate of glass placed behind the armor was not shattered, showing the ability of the material to absorb vibrations. The shots were fired from a distance of 50 ft.—*R. R. Engineering News.*

[England.]

Two armor plates, manufactured by Messrs. Cammell & Co., of Sheffield, were tested on board the Nettle, target ship, at Portsmouth, The first plate tested was 6 inches thick, with a superficial area of 8 feet by 6 feet, backed in the usual manner. At a range of 30 feet the plate was fired into five times with a 6-inch breech-loading gun, the 100-lb. Holtzer forged steel armor-piercing projectile being used in each case. The penetrations ranged from 2½ inches to 2¾ inches, but as no

cracks were developed, the plate was capable of resisting five more projectiles under the same conditions. In each case the velocity was 1960 foot-seconds, and the projectiles were broken into small pieces. The second plate was 4 feet square and 4 inches thick, against which three rounds were fired from a 5-inch breech-loading gun, the projectile weighing 50 lbs. At the first round the projectile had a striking velocity of 1400 foot-seconds, and at the other rounds of 1750 foot-seconds. At each round the projectile splashed on the face of the plate, and while the shells were pulverized, the plates were only scratched. No cracks were developed, and, as the plate was apparently uninjured, the results in both cases were regarded as highly satisfactory.—*Journal of the Royal United Service Institution.*

Vickers 6-inch Gun.

Messrs. Vickers' 6-inch quick-firing gun, in which so much anticipatory interest has been taken, has been tried at Portsmouth, and the results have surprised even the ordnance officials of the government. It differs in many respects from service guns. In the first place it is longer than most other 6-inch guns, being 22 feet 6 inches, while 20 feet is the usual length of the bore, including chamber. It weighs 7 tons 8 cwt., about the same as the service 6-inch gun, but it has great advantages. In the first place the breech-block, instead of having the usual uninterrupted screw with screw and plane surfaces alternating, has only two plane parts in the circumference, the other screwed parts being of various diameters. This gives a lighter breech-block with greater resistance, since the screw thread is operative round a greater part of the circumference of the block. Again, the cordite charge does not require to be in casing, so that in this way the cost of each round is reduced by nearly £2, while the saving of the weight of the cartridge casing is an important item in the stores. But all these incidental advantages are as nothing to the high muzzle energy developed and the consequent great penetrative power. The best of our 6-inch guns give a velocity of 2200 foot-seconds; this new gun repeatedly developed 2780 foot-seconds, the pressure being 15.9 tons. The striking energy was 5374 foot-tons, whereas 3356 foot-tons is the highest with our service 6-inch guns. This is only equaled by the Elswick 8-inch 20-ton quick-firing gun, which with a 210-lb. shot and 46 lbs. of cordite develops 5357 foot-tons, although with a 250-lb. shot they get 6167 foot-tons. The Vickers' 7-ton gun, indeed, has got quite 66 per cent. more energy for the same size of gun than any other weapon, and there is with this even a higher speed of firing. Aiming at a target 3000 yards off the gun was fired at the rate of one round per 10 seconds, while unaimed shots were fired at the rate of one shot in 9½ seconds. This equals the ordinary performance with 100-lb. shot, while with the 250-lb. or 300-lb. shots of the 8-inch guns, giving little more energy, the rate of firing does not quite reach three rounds per minute. The results are regarded as most satisfactory, for although the gun was fired in all 110 times, examination showed that it sustained no injury whatever.—*United Service Gazette.*

SHIPS OF WAR.

[China.]

Hai Yung.

On the 15th September the first of the three cruisers which are being built for the Chinese Government was launched from the Vulcan Yard at Stettin in the presence of the members of the Chinese Legation and of the Minister Hsu Chin Cheng, who performed the christening ceremony after the sacrifice, according to Chinese custom, of a pig and sheep on board. The cruiser was named the Hai Jung, or Wide Ocean. Her dimensions are as follows: Length, 328 feet; beam, 41 feet; draught, 23.7 feet. When fully armed and carrying 220 tons of coal, the ship will have a displacement of 2950 tons and a mean draught of 16.4 feet. She has two screws, driven independently by engines which indicate 7500 H. P., and the maximum speed guaranteed is 19½ knots. The cruiser carries three guns of 15 centimetres (5.8 inches) calibre, and eight of 10.5 centimetres (4.1 inches), by Krupp, all Q. F., six Maxims, and one gun for a boat. There are three torpedo tubes, one below the water-line and two on deck. Of the numerous watertight compartments, several on the water-line are filled with coal.—*Journal of the Royal United Service Institution.*

Building Program.

Since the peace of Shimonoseki China has purchased or ordered the following ships of war:

1. For the Peiyang Squadron: the torpedo cruisers Feiying and Feiting already delivered. The former has a tonnage of 850, engines of 5500 H. P., and a speed of 22 knots. The latter displaces 1000 tons, with 2400 I. H. P., and a speed of 21 knots. Under construction are three armored cruisers, each of 2850 tons, 7500 horse-power, and 19½ knots speed; two armored cruisers of 4300 tons displacement, 17,000 horse-power, and 24 knots speed. The three smaller cruisers and the Feiying built at Stettin, the others at Armstrong, all to be delivered by spring, 1898.

2. For the Nanyang Squadron: delivered are two Schichau torpedo-boats of 130 feet length and 24 knots speed, and two Vulcan boats of 140 feet length and 24 knots speed. Under construction at Schichau works are four destroyers of 195 feet length and 32 knots speed.

During the late war the crews of the vessels behaved well under fire, as a rule, being made up almost exclusively from inhabitants of the coast regions, a hardy, seafaring people. The personnel of the officers has been reorganized to some extent. There is no commissary department, however. The crew contract at present with the ship's cook. The medical department is still in bad shape. There is a lack of centralization and no proper mobilizing system.—*Deutsche Heereszeitung.*

[England.]

Canopus.

The Canopus battle-ship was launched from the building slip at Devonport. She was designed by Sir W. H. White, and measures 390 ft. be-

tween perpendiculars by 74 ft. beam by 26 ft. draught. She will be fitted with engines aggregating 13,500 horse-power, supplied with steam by Belleville boilers designed for a working pressure of 300 lbs. per square inch, which will be reduced to 250 lbs. before entering the high-pressure cylinders. The designed speed of the boat is 18½ knots, and she will carry 1900 tons of coal. Protection is afforded by an armored deck and by belt armor, the latter being 6 in. thick, whilst the barbette armor will be 10 in. to 12 in. thick. Plating 2 in. thick, of nickel steel, extends from the belt to the bows, and is arranged to support the ram. The principal armament of the Canopus will consist of four 12-in. wire guns, and there will be an auxiliary armament for twelve 6-in. quick-firers, the latter being protected by Harveyed plates 6 in. thick.

Pelorus.

The third-class cruiser Pelorus has satisfactorily concluded her trials, reaching a speed of 19.7 knots under natural draught.

Arrogant.

The second-class cruiser Arrogant maintained a mean speed of 19.6 knots during the eight hours' full-power trials, with a total of 10,290 indicated horse-power. During the 30 hours' trial at 2000 H. P. the speed was 12.5 knots; with 30 hours' run at 7624 I. H. P. a speed of 17.8 knots.

The coal consumption, as a result of thirty hours' test under varying conditions, was as follows: During the first 8 hours the steam cut-off in the high pressure cylinder was 51.3 per cent, giving an I. H. P. of 2087. The coal consumption for the main engines was 4909 lbs., or 2.35 lbs. per I. H. P.; that for the auxiliary engines was 962, making a total of 2.81 lbs. per I. H. P. After this the cut-off was altered every few hours, varying from 23.8 to 60, giving a mean coal consumption of 2.1 lbs. per I. H. P. for the main engines alone, and 2.8 lbs. with the auxiliary engines working, the average speed being 12.48 knots.

Rolling Gun Platform.

The Admiralty have ordered designs for a round-bottomed vessel, which is to be built for the purpose of teaching gunners to fire from a rolling platform. The vessel is to be about 150 feet long, and when completed will be attached to the Cambridge, gunnery school-ship. Rolling platforms have been in use ashore, but this is the first vessel of the kind ever built in the British Navy.—*Journal R. U. S. Institution.*

Chamois.

The Chamois, torpedo-boat destroyer, built by the Palmer Company, of Jarrow-on-Tyne, carried out her second three hours' 30-knot trial at Portsmouth on the 23rd of September under peculiar circumstances. Starting at 8.45 A. M., the engines had worked up to their required speed when the vessel had to return into harbor owing to a hot bearing. A new bearing was substituted, and the vessel started again, but the steering gear failed to answer, and it was found that a pin had been carelessly removed. This defect was made good and a fresh start was made, the official trial being at 2.25. On the measured mile, with 397

revolutions, a mean speed of 30.368 knots was maintained, and the mean speed of the three hours' run, with 394.4 revolutions, was 30.22 knots. When the vessel returned into harbor with a hot bearing she had to ship fresh coal so as to restore her to her proper load, and this occupied some time.

The Chamois, torpedo-boat destroyer, on the 1st inst., left Portsmouth for a 12 hours' coal-consumption trial at a speed of 13 knots, but owing to her falling in with thick weather the trial lasted only 11¼ hours. While the mean speed of the run was 13.046 knots, the consumption worked out at 1.86 lb. per unit of power; showing that the vessel can steam at this speed for 36 knots per ton of coal, giving her a radius of 2880 knots for her full load of 80 tons of coal.

Mallard.

The Mallard, torpedo-boat destroyer, built by Messrs. J. I. Thornycroft & Co., of Chiswick, left Chatham Dockyard on the 24th of September for her official full-power three hours' trial, the results being a speed of 30.096 knots as a mean of six runs on the measured mile, and 30.115 knots during the three hours' continuous run. The vessel afterwards returned to Chatham.

Crane.

The Crane, the fifth of the 30-knot torpedo-boat destroyers delivered by Messrs. Palmer, of Jarrow-on-Tyne, carried out her first official trial at Portsmouth on November 10th with satisfactory results. The weather was hazy and the sea smooth, but the wind, when the Crane was steaming against it, was strong. During the last hour the engines were worked up to more than 400 revolutions a minute, but the mean of the three hours was 395.5, giving a speed of 30.138 knots. The mean of six runs on the measured mile gave a speed of 29.62 knots, but the highest speed past the mile was 32.75 knots. While the vessel was running on the mile the air pressure was 2.9 in. and the vacuum 25.2 in. The principal condition of the trial was that she was to make 30 knots with a coal consumption of 2.5 lbs. per unit of power per hour; but though the consumption was not worked out, it is believed to have been economical. The engines maintained a mean of 6428 horse-power, working smoothly, while there was an entire absence of vibration.—*Engineering.*

Powerful.

The Powerful, cruiser, Captain the Hon. H. Lambton, began her torpedo trials, under the direction of the staff of the Vernon, in Stokes Bay, October 1. The vessel is provided with four submerged torpedo tubes, two being abeam and the other two on the quarter, and in the course of the trials two Whiteheads were fired from the starboard quarter and one from each of the other tubes. The engines were worked up to four-fifths of their natural power, and the time taken at one of the runs over the measured mile was two seconds under three minutes, showing that the ship was traveling at the rate of slightly over 20 knots. Torpedoes were fired while the ship was turning at various degrees of helm, and the results were regarded as highly satisfactory.

Illustrious.

The results of the 30 hours' coal-consumption trial of the Illustrious, battle-ship, built at Chatham, are as follows: Draught of water, forward,

25 ft. 7 in., aft, 26 ft. 6 in.; speed, 14.51 knots; steam pressure in boiler, 142 lbs. per square inch; revolutions, 83.1 starboard, 83.0 port; horse-power 3101 starboard, 3054 port—total, 6155; coal consumption, 1.77 lb. per indicated horse-power.

Porpoise.

The Porpoise, cruiser, which is to be commissioned at Portsmouth for service on the Australia station—where she will relieve the Pylades, cruiser, Com. Horace R. Adams—after swinging on the 15th November for the adjustment of compasses, carried out a two hours' natural-draught trial, on the completion of an extensive refit of hull, boilers and engines. She was required to develop 2200 horse-power, but without any air pressure, and with 128 lbs. of steam in the boilers the engines gave 2237 indicated horse-power. The revolutions were 132 per minute, which gave the ship a speed of 15½ knots.

Sirius.

The Sirius, cruiser, Captain G. M. Henderson, was taken into the Channel on the 16th November from Plymouth for a three hours' full-power trial, preparatory to leaving for the Mediterranean station with relief crews for the Fearless and the Hebe. The mean results were: Steam in boilers, 146 lbs.; air pressure in stokeholds, 0.37 in.; vacuum, starboard, 26.6 in.; port, 27.1 in.; revolutions, starboard, 126.1; port, 126.2; indicated horse-power, starboard, 3427; port, 3476—total, 6903; speed, 16.8 knots.—*Engineering.*

Pomone.

The latest addition to her Majesty's fleet, the third-class cruiser Pomone, was launched from Sheerness, November 25. She is one of eleven practically similar vessels, eight of which are either built or building, whilst the remainder are on the programme, and are known as the Pelorus class. They are nominally 20-knot third-class cruisers, and carry eight 4-in. quick-firing guns as their main armament, with eight three-pounders, other small guns, and two torpedo tubes as the secondary armament. The displacement is 2135 tons; length, 300 ft.; beam, 36 ft. 6 in.; draught, 17 ft.; and she is propelled by two propellers with 7000 indicated horse-power.

She forms one of a squadron which should prove of great importance for dispatch work, as not only can they attain a high speed, but are of a size capable to work well in a heavy sea, and are sufficiently armed to give a good account of themselves against torpedo destroyers and other vessels of their own class. These vessels have 2-in. protective decks, but are otherwise only lightly armored round the gun positions.—*Engineer.*

Sheikh.

H. M. S. Sheikh, twin-screw river gunboat, 145 ft. long by 24 ft. 6 in. beam (a sister ship to the Sultan, which is now in Egypt), constructed by Messrs. Yarrow & Co., Limited, had her official two-hours' speed trial in the river Thames, November 4. The draught was only 2 ft., carrying a load of 35 tons, and the mean speed for the two hours was

11.466 knots, equal to 13.177 statute miles, with only 140 lbs. steam. The boilers are able to work at 200 lbs., so that a considerably higher speed could have been maintained, if wished. The above vessel is one of several building to Admiralty designs for use on very shallow rivers. The armament consists of two 12-pounder quick-firing and several automatic guns.—*Engineering.*

Condor and Rosario.

An Admiralty order has been issued directing two new war-sloops, designed by Sir W. H. White, to be laid down at Sheerness Dockyard. They are to have a length of 180 ft., beam of 32 ft. 6 in., and a mean load draught of 11 ft. 6 in., with a displacement of 960 tons, and are to be fitted with engines of 1400 H. P. under forced draught, with a speed of 13.25 knots, and 1100 H. P. under natural draught, with a speed of 12.6 knots. Their armament will consist of six 4-in. and four 3-pounder Q. F. guns, and they are to be named the Condor and Rosario.—*Journal of the Royal United Service Institution.*

Vindictive.

H. M. new cruiser Vindictive, which was floated out at Chatham, Thursday, December 9, is of the same class as the Furious, Arrogant and Gladiator. The length is 320 ft.; breadth, 57 ft. 6 in.; mean draught, 21 ft.; and displacement, 5805 tons. She is fitted with twin screws, and her engines, which have been built in Chatham Dockyard, will develop with natural draught 10,000 indicated horse-power, the speed of the ship being 19 knots. There are eighteen boilers of the Belleville type in three water-tight compartments. The engines are triple expansion, with cylinders 26 in., 42 in., and 68 in. diameter respectively, and 39-in. stroke. The coal capacity is 1175 tons, which would enable the ship to steam 37½ days at 10 knots. The fore conning tower is of 8¾-in. Harveyed steel of circular form. From the base of the conning tower a forged steel communication tube, 4 in. thick, is led down to the armor deck, inside which are the controlling shafting to the steering engines, etc. On the bows there is protective plating of 2 in. nickel steel, and the protective deck is composed of two thicknesses—on the flat one of 1 in. and one of ½ in., and on the slopes one of 2 in. and one of 1 in. The armament comprises four 6 in., six 4.7 in., eight 12-pounder and three 3-pounder quick-firing guns, one 12-pounder field gun, and five Maxim machine guns. There are two submerged tubes for 18-in. torpedoes. The complement of officers and men is 419. The first keel plate was laid down on January 27th last year.

[France.]

Guichen.

The first-class cruiser Guichen, built as a commerce destroyer, was successfully launched from the building slip of the Société des Ateliers et Chantiers de la Loire at St. Nazaire, October 26. Her dimensions are as follows: Length, 436 ft.; beam, 54 ft. 10 in.; maximum draught, 24 ft. 6 in., with a displacement of 8277 tons. She will be provided with 36 water-tube boilers of the Lagrafel and D'Allest type, divided into six groups, placed before and abaft the machinery; the total grate sur-

face will be 163 square metres; the heating surface 4692 square metres. She will be fitted to burn either coal or petroleum fuel; and pulverizers will be fitted for the petroleum when it is used in conjunction with the coal. The ship will be driven by three screws, and the engines are to develop 23,670 I. H. P., giving a speed under forced draught of 23 knots, with a coal consumption of 160 kilogrammes per square metre of grate surface; under natural draught the engines are to develop 14,500 I. H. P., giving 105 revolutions, with a coal consumption not exceeding 0.87 kilogramme per H. P. per hour during a 24-hour run; and it is expected that a speed of 20 knots will be easily maintained. The ship is built of steel, but she is to be wood sheathed and coppered; there is an armor turtle-back deck 2.3 inches thick, and a cofferdam running right round the ship, to be filled with cellulose or some similar substance. The armament will consist of two 6.4-in., six 5.5-in. and ten 1.8-in. guns, all Q. F. The only protection for the 6.4-in. guns will be 2-in. shields of chrome steel; but there will be a conning tower protected by 6-in. Harveyized steel armor, and communicating with the armored deck by an armored tube of similar thickness, and the six 5.5-in. guns will be in casemates, also protected by 2-in. chrome steel. There are no torpedo discharges.

D'Estrées.

The new third-class cruiser D'Estrées was launched at Rochefort, October 27. She is 308 ft. 6 in. long, with a beam of 39 ft., a mean draught of 16 ft. 4 in., and a displacement of 2450 tons. Her engines are to develop 8500 I. H. P., giving a speed under forced draught of 20.5 knots. The armament will consist of two 138-mm. (5.5-in.) and four 100-mm. (3.9-in.) Q. F. guns, with eight 3-pounder Q. F. guns. Her cost will be 5,205,000 francs, and she is to be completed in 1899, having been laid down in July of last year. She is built of steel, but is to be wood sheathed and coppered, as she is intended for service on foreign stations.

Dunois.

The torpedo-aviso Dunois was launched at Cherbourg. She was laid down in March of last year, and is the first of her type to be fitted with Normand water-tube boilers. Her dimensions are: Length, 241 ft.; beam, 27 ft. 6 in., with a displacement of 890 tons. The engines are to develop 6400 I. H. P., giving a speed of 22.6 knots; the coal stowage will be 137 tons, giving a radius of action of 5000 miles at 10 knots, and 560 miles at full speed. Her armament will consist of six 6-pounder and six 3-pounder Q. F. guns, and she will have no torpedo equipment.—*Journal of the Royal United Service Institution.*

Cassard.

The new second-class cruiser Cassard has made a successful full-speed trial at Cherbourg; the engines developed 10,143 I. H. P., being 643 H. P. over the contract, with 137.8 revolutions, which gave the ship a mean speed of 19.8 knots during the four hours' run; the coal consumption per horse-power per hour was 0.876 kilogramme. The last trial of the Du Chayla, another ship of the same class, was not so successful, as the engines only developed 8900 I. H. P., instead of the contract horse-power of 9500.—*Journal of the Royal United Service Institution.*

Montcalm.

On November 17th the Minister of Marine signed the contract for the building of an armored cruiser, to be named the Montcalm, by the Forges et Chantiers Co. The principal dimensions are to be as follows: Length, 456 ft.; beam, 64 ft.; depth, 43 ft.; displacement, 9515 tons. Steam is to be furnished by 20 single Normand boilers, or by 8 double-ended Normand-Sigandy and 4 single Normand boilers. Furnaces are to be fitted for liquid fuel as well as for coal. Three vertical triple-expansion engines, each turning a separate screw, to develop a total of 19,600 horse-power, and giving a speed to the ship of 21 knots. A belt of 6-in. armor to extend along the water-line, above which the sides in wake of the cellular structure are to be protected by armor varying in thickness from ⅔ to 3¾ in. A protective deck, and a second thinner splinter deck, will complete the protection of the vitals.

The armament to consist of two 7.6-in. guns, model 1896, placed in turrets, one forward, one aft; eight 6.4-in. rapid-fire guns in armored casemates, disposed like those on the Entrecasteaux; four 4-in. rapid-fire guns, protected by shields, on the spar-deck; sixteen 47-mm. and six 37-mm. guns on the decks, bridges and in the two military tops. Two submerged torpedo tubes. The designs are those of M. Bertin. The turrets and ammunition hoists to be worked by electricity or hand.—*Le Yacht.*

[Germany.]

Kaiser Wilhelm II.

The Kaiser Wilhelm II, just launched, is the sister ship of the Kaiser Friedrich III, which was launched on July 1st, 1896. She is built entirely of German steel, and her dimensions are as follows: Length, 377 ft. 4 in.; beam, 67 ft.; and with a mean draught of 25 ft., a displacement of 11,130 tons. Protection is afforded by a 11.8-in. water-line belt of hardened steel, tapering forward to 6.4 in., which extends from the ram aft for three-fourths the length of the ship, with a depth of 6.5 ft.; the turrets for the heavy guns have 9.8-in. armor, also of hardened steel, while the guns of the secondary battery are protected by 6-in. armor. The armament consists of four 24-cm. (9.4-in.), eighteen 15-cm. (5.9-in.), twelve 8.8-cm. (3.3-in.), and twenty small and machine guns, all quick-firers, with six torpedo tubes, five of which are submerged. The engines are to develop 13,000 I. H. P., driving three screws, while the estimated speed is to be 18 knots.—*Journal of the Royal United Service Institution.*

Prince Bismarck.

The German armored cruiser Prince Bismarck, the first of the type yet built in Germany, was launched on the 25th of September from the Imperial yard at Kiel. She was laid down in April, 1896. Her length is 393.6 ft., beam 67 ft., with a displacement at 26.24 ft. draught of 10,650 tons. She has three sets of triple-expansion engines, the collective power being 14,000 indicated horse-power. The armor belt, which extends from stem to stern, is 7½ ft. deep, and there is also a protective deck of 1.9 in., with a second armored deck aft below the usual protective deck. The coal capacity is 1000 tons. There will be four 9.6-in. quick-firing guns in the armor turrets, and twelve 6-in. guns in separate

casemates on small revolving turrets; amidships ten 3.6-in. guns behind shelters, and ten 1.6-in. machine guns. The cruiser has six torpedo tubes for 18-in. torpedoes, all with the exception of the stern tubes being under water. The speed is expected to be 19 knots, and the ship's complement 560 men.—*Engineering.*

Ersatz König Wilhelm.

The Ersatz König Wilhelm, which is to replace the König Wilhelm, is being built by Krupp, to be ready by 1901. Her length is to be 125 metres, beam 20, draught 7.3, and displacement 11,000 tons. She is to have three screws, driven by engines of 13,000 horse-power in all, and it is hoped that she will make 18 knots. Her belt, 30 cm. thick, is to be of hardened nickel steel, and the turrets for the heavy guns are to be covered with plates of the same metal 25 cm. thick. The ironclad deck, which is to protect the vitals, especially the engines and boilers, will be 7½ cm. thick. The armament will be the same as that of the Kaiser Friedrich der Dritte. The cost of the vessel will be 14,120,000 marks, exclusive of guns and torpedoes.

The newest torpedo-boat built by Schichau has just begun her trial trips. It differs from the older boats only in the engines, which are built for greater speed. The eleven armored gunboats of the Wespe type will shortly be removed from the active list, and the type itself will probably disappear from the German Navy. In 1897-98 the personnel of the German Navy will amount to 23,302 men.—*Admiralty and Horse Guards Gazette.*

It is stated, on the authority of the *North-German Gazette*, that the construction of dispatch boats for the German Navy will be discontinued. Beyond battle-ships and armored vessels for coast defense, only large and small armored cruisers will be built in future. The small cruisers will be employed in the same manner and for the same purposes as those for which dispatch boats have hitherto been employed. Their decks will be protected by armor, and they will be equipped with quick-firing guns. Their engines and construction will be such as to enable them to attain a very high speed. "As a matter of course," it is stated, "there will continue to be torpedo-boats and school ships for the training of naval cadets and boys for the navy."

[Italy.]

Emmanuele Filiberto.

There was launched on the 30th of September, in the presence of the Prince and Princess of Naples, at Castellamare, the new Italian battle-ship—named after the victor of Saint Quentin and the liberator of Piedmont. Her principal dimensions are: Extreme length, 342 ft.; extreme breadth, 68.6 ft.; average draught, 24.5 ft.; and total displacement, 9800 tons. The engines are expected to give 13,500 indicated horse-power, with a maximum speed of 18 knots. The hull is of steel throughout, with a double bottom rising to the level of the deck along the entire length of the engine-rooms, while from stem to stern extends an armored deck of a thickness varying from 2.7 in. to 1.5 in. The bridge and the guns are protected by Harveyized steel armor, varying from 1½ in. to

6 in. in thickness, according to position, while the armor of the fore and after turrets is 7 in. thick. The armament of the vessel consists of four 9.9-in. guns, two of which are placed in the fore and two in the after turret; eight 5.9-in. quick-firing guns, situated in the central tower; eight 4.6-in. and eight 2.2-in. quick-firing guns placed laterally on the central tower. Ten other small-bore quick-firing guns, distributed fore and aft, and four torpedo tubes complete the armament. It is hoped that the Emmanuele Filiberto will be ready for service at the beginning of 1899.—*Engineering.*

Garibaldi.

The Italian armored cruiser Garibaldi was launched on the 26th of September at Genoa. Like the Varese, floated some weeks ago, she belongs to the new type of medium-sized warships which has recently found favor in the eyes of Italian naval engineers, and in the construction of which they appear to excel. Sister vessels to the Varese and Garibaldi were built some time ago for the Spanish and Argentime navies, and in view of their satisfactory performances it was decided to construct others of the same type for the Italian navy, adding such improvements of detail as experience might suggest. The Garibaldi is of 6840 tons displacement, with an extreme length of 326 ft. and an extreme breadth of 60 ft. The average draught is 23 ft. She is protected by an armored belt 7 in. thick and 54 in. wide at the prow and 47 in. at the stern. Her armament will consist of two 80-ton guns of 254 mm., say 9.75-in. calibre; six 5¾-ton quick-firing guns of 120 mm., say 4.75-in. calibre; and ten 12-ton quick-firing guns of 152 mm., say 5.75-in. calibre; in addition to the usual Maxims, mitrailleuses and torpedo tubes. Her engines are expected to give a combined total of 13,000 indicated horse-power, with a normal speed of 19 knots. The Garibaldi will be ready for service in January next. Her total cost will be about 14,000,000 lire, say 538,000*l.*—*Engineering.*

Naval Budget.

The Italian naval budget for 1897-98 amounts to $20,244,929. The personnel is to be increased by 1084 men. The programme includes the completion of the San Bon, E. Filiberto, Garibaldi, Varese, Puglia, Agordat, Coatit, Carlo Alberto, and Vittor Pisani; the armament of the Garibaldi and Varese; rebuilding the Marc-Antonio-Colonna. The building programme comprises the construction of 89 new vessels, viz., one first-class battle-ship, two of the second-class, ten cruisers, ten torpedo cruisers, five gunboats, and sixty-one torpedo-boats.—*Le Yacht.*

[Japan.]

New Cruiser.

Japan has ordered a cruiser from the Chantiers de la Loire, work to be commenced at once. The vessel is to be 446 ft. long, 59½ feet beam, 25 feet draught, and to displace 9436 tons. Her engines are to develop 17,000 I. H. P. and give a speed to the ship of 20 knots. There is to be a light steel protective deck, and a 6.2-in. steel belt extending the full length. She is to have a battery of 7.8-in. breech-loaders in two turrets, fore and aft, with twelve 5.9-in. quick-firers, eight of which are in armored casemates, the other four on the upper deck will have shields. In addition there will be twelve 2.9-in. and twelve 1.8-in. guns. The

vessel is to be propelled by twin screws, with triple-expansion engines and three groups of Belleville boilers, to be built at St. Denis.—*United Service Gazette.*

Japanese Ships of the Line.

The following list, taken from the *Japan Weekly Mail*, giving the names and tonnages of the war vessels of Japan, their armaments, and the year in which they were launched, will no doubt be of interest to our readers:

	Tonnage.	Guns.	When launched.
Fuji (battle-ship), steel	12,649	38	1896
Yashima (battle-ship), steel	12,517	38	1896
Chinyen* (battle-ship), steel	7,335	20	1881
Itsukushima (coast defence), steel	4,278	33	1889
Matsushima (coast defence), steel	4,278	30	1890
Hashidate (coast defence), steel	4,278	31	1891
Takasago (cruiser), steel	4,227	30	1897
Yoshino (cruiser), steel	4,216	36	1892
Fuso (ironclad corvette), steel	3,777	26	1877
Naniwa (cruiser), steel	3,709	24	1885
Takachiho (cruiser), steel	3,709	24	1885
Akitsusu (cruiser), steel	3,150	23	1892
Izumi (cruiser), steel	2,967	22	1883
Suma (cruiser), steel	2,700	24	1895
Chiyoda (steel-clad cruiser)	2,439	27	1890
Saiyen* (cruiser), steel	2,300	13	1883
Kongo (corvette), wood, with iron sheathing	2,284	17	1877
Hiyei (corvette), wood, with iron sheathing	2,284	19	1877
Heiyen* (gunboat), steel	2,100	15	1888
Tsukuba (corvette), wooden	1,978	11	1871
Takao (cruiser), steel frame, armored	1,777	16	1888
Yayeyma (despatch boat), steel	1,609	11	1889
Tenryu (sloop), wood	1,547	12	1883
Katsuragi (sloop), iron and wood	1,502	17	1885
Yamato (sloop), iron and wood	1,502	14	1885
Musashi (sloop), iron and wood	1,602	14	1886
Tsukkushi (cruiser), steel	1,372	13	1883
Kaimon (sloop), wood	1,367	13	1882
Amaiki (sloop), wood	926	13	1877
Tatsuta (torpedo gunboat), steel	864	6	1894
Iwaki (gunboat), wood	667	6	1878
Oshima (gunboat), steel	640	10	1891
Maya (gunboat), iron	622	6	1886
Atago (gunboat), steel and iron	622	4	1887
Chokai (gunboat), iron	622	4	1887
Akagi (gunboat), wood	622	10	1888
Soko* (gunboat), wood	610	5	1865
Chinto* (gunboat), steel	440	7	1879
Chinsei* (gunboat), steel	440	7	1883
Chinhoku* (gunboat), steel	440	7	1879
Chinpen* (gunboat), steel	440	7	1881
Chinchu* (gunboat), steel	440	9	1881
Hosho (gunboat), wood	321	5	1871
Kaikyo,* wood	1,450		

Vessels now building are:

Name.	Tonnage.	Guns.
Shikishima (battle-ship), steel	15,037	50
Kasagi (cruiser), steel	4,978	30
Chitose (cruiser), steel	4,836	30
Akashi (cruiser), steel	2,800	24
Miyako (despatch boat), steel	1,800	12

The Akashi and Miyako are to be launched this year. The other three vessels are expected to be completed in 1899. It is stated that the Shikishima will be the largest battle-ship in the world. Those marked with an asterisk in the above list were captured from China during the war. The Kaikyo was captured near Port Arthur; it is pretty old, and is now undergoing repairs and re-armament. There are besides 29 torpedo-boats of different sizes. The number of vessels that have sunk or fallen into disuse is twenty-six in all. According to the latest information from Japan, the Japanese Admiralty have just ordered one large and eight small torpedo-boats to be built in Germany. The large one is to be 46 metres long, to have two screws and to steam 28 knots an hour. The smaller boats are to be 39 metres long and to steam 25 knots. All are to have quick-firing guns.—*Engineering.*

The Naval Expansion of Japan and Russia.

Whatever truth there may be in the alarmist telegrams which periodically come from the Far East, that war between Japan and Russia is inevitable, there can be no doubt that in a comparatively short time the naval forces of these two powers will be the strongest on the Pacific. In a recent issue we gave a list of the names and the tonnage of the warships of Japan with their armaments, and when it is remembered that they are all concentrated within easy reach, it is seen that they form a force which may at any time become a very powerful factor in any question which may be submitted to a settlement by force of arms. Mr. Charles Cramp, of the well-known shipbuilding firm of Philadelphia, has recently been visiting the shipyards of Europe, and he has been surprised at the amount of work which is being done for the Japanese. He comes to the conclusion that unless Russia and the United States awaken to their position in the Pacific, Japan will be able to defy either of them in three years, and both together in less than ten years. He states that the development of the Japanese Navy since the war is not to be described as progress; it is a cyclone, Japan being second only to England in naval activity, being ahead of France, much in advance of Germany, and vastly in the lead of Russia and the United States. Moreover, her ships are all of the best and highest types of naval architecture. During the course of his travels he observed the following ships under construction for the Japanese:

1. Three 14,800-ton battle-ships, which are well advanced, at Armstrong's, Thompson's, and the Thames Iron Works respectively.

2. One battle-ship of about 10,000 tons, commencing at Armstrong's.

3. Four first-class armored cruisers of 9600 tons displacement and 20 knots speed: two at Armstrong's, one at the Vulcan Works, Stettin, and one at the Forges et Chantiers, France.

4. Two 5000-ton protected cruisers of about 23 knots speed, one at San Francisco, and one at Philadelphia.

5. One protected cruiser of 4300 tons, and about 23 knots, at Armstrong's.
6. Four 30-knot torpedo-boat destroyers at Yarrow's.
7. Four more of similar type at Thompson's.
8. Eight 90-ton torpedo-boats at the Schichau Works, Elbing.
9. Four more of a similar type at the Normand Works, France.
10. Three 3000-ton protected cruisers of 20 knots, three torpedo gunboats, and a despatch vessel, at the Imperial Dockyard, Yokosuka, Japan.
11. A fifth armored cruiser of the type already described (9600 tons and 20 knots), to be built at Yokosuka.

And he has no hesitation in saying that the vessels Japan is building in the shipyards of England, France and Germany are superior to any vessels those nations are building for themselves, class for class. Discussing the question against whom the naval power of Japan is destined to be turned, he evidently thinks it will be Russia, for there are many points on which differences may arise between that power and Japan. The Russian Navy estimates for next year have been prepared and they show a total of 8¼ millions sterling, as compared with 5½ millions five years ago, but of that amount a considerable part is to be spent on naval harbors, barracks, arsenals and workshops. For instance, 1¾ millions is to be spent on the extension of Vladivostock harbor, and on ice-breaking steamers to test practically the experiment of keeping it open throughout the winter, and other considerable sums are to be spent on other harbors, and on dredges. About 4½ millions are to be spent on shipbuilding, or about 700,000*l.* more than in the previous year. Some of the ships are of large size, but neither in speed nor in equipment do they seem to have been kept so nearly up to date as those being built for Japan. As regards the number of ships, Mr. Cramp comes to the conclusion that in the race for naval supremacy in the Pacific, Japan is gaining, while Russia and the United States are losing ground. It is quite evident that after the next struggle which takes place, Japan will be in a stronger position to retain the stakes and the spoils of victory than she was on the conclusion of the war with China; and, therefore, that it is probable when the next treaty comes to be signed at Shimonoseki, the representatives of Japan will not be found so pliant as they were on the occasion of the last, when they had to resign some of their original claims on account of the intervention of European diplomacy. The Japanese show plainly that they have more faith in ships and guns than in diplomacy.—*Engineering.*

[Russia.]

Signaling Experiments.

Last year experiments in night signaling were made on board the Admiral Ushakov at sea at various distances. At a distance of 2 miles the number and color of the lanterns could be distinguished with the naked eye, but at 4 miles this could only be done with a glass, and at 6 miles it was difficult to do so even then. The atmosphere was quite clear at the time. This winter fresh experiments were made with the electric signals of Colonel Tabulevich, but were soon abandoned, and the lanterns of Colonel Miklashevski were again tried. These were spread over a considerable length of time and were made under various conditions of atmosphere and wind, and were entirely satisfactory, as

we learn. The force of the wind was from 5 to 6 balls, according to the Beaufort anemometer, and the lantern never once went out. Signals with red and green lights were made from the marine telegraph station 100 feet above the level of the sea in clear weather, during some 45 minutes, which were watched at St. Petersburg from the third story of a house in the Galley harbor. The distance was upward of 25 versts, yet all the flashes were clearly distinguishable, and only one lantern had to be replaced. The flashes were like those of vivid lightning or the glare from a conflagration, and could not be confused with anything else. —*Journal of the Royal United Service Institution.*

Gilyak.

The Gilyak, twin screw gunboat, built at the Admiralty works on the Neva, was launched October 6. She is intended for Chinese waters, and was laid down in March, 1896. Her dimensions are 108 feet length, 37 feet beam, 963 tons displacement. Two triple expansion engines, steam supplied from Belleville boilers, to develop about 1000 I. H. P., giving a speed of 12 knots. The armament consists of one 4.7-in., five 2.95-in., four 1.85-in. rapid-fire guns, and two 2½-in. field guns. There are two torpedo launching tubes.—*Mittheilungen aus dem Gebiete des Seewesens.*

Svetlana.

The Russian Imperial yacht Svetlana, built at Havre by the Society Forges et Chantiers, has had satisfactory trials. She is a cruiser yacht with protective deck, of great speed, destined to carry the flag of the Grand Duke Alexis. Her principal dimensions are as follows: Length, 330 ft.; beam, 42.5 ft.; maximum draught, 18.75 ft.; displacement, 3828 tons. Her engines of 8500 horse-power to give a speed of 20 knots. She carries two military masts, with small tops for search-lights, a signal yard, three smokestacks, and very pronounced ram bow. Passage-ways, conning tower and communication tubes, as well as deck openings, are protected by armor plates varying from 2 to 5 in. in thickness. The triple expansion four-cylindered engines drive twin screws. The armament consists of six 6-in., ten 47-mm. rapid-fire guns, four torpedo launching tubes. The first trials for coal consumption were held November 4 under a speed of ten knots. On November 24 and 25 were held the speed trials and tests of battery. The speed trial lasted 6 hours with a mean speed of 20¼ knots, the highest speed reached was 21.625 knots.—*Le Yacht.*

[Spain.]

Expansion of the Fleet.

The strengthening of the Spanish fleet is proceeding fairly rapidly. The first-class armored cruiser Emperator Carlos V has concluded her steam trials satisfactorily and is approaching completion; she is a vessel of 9235 tons displacement, with engines developing 15,000 I. H. P., giving a speed under forced draught of 20 knots; her length is 380 ft., beam 67 ft., with a maximum draught of 25 ft.; protection is afforded by a 6.5-in. turtle-back armored deck, the two turrets for the heavy guns having 10-in. armor, and she has also a central battery with 2-in. steel plating; her armament consists of two 11-in. Hontoria guns, in turrets, one forward and one aft, eight 5.5-in. Q. F., four 3.9-in. Q. F., with six 3 and 1-pounder Q. F. and six machine guns; she was built

at Cadiz. There are five other first-class armored cruisers under construction and four already completed. The new first-class protected cruiser Alfonso XIII, a vessel of 5000 tons, 11,000 tons I. H. P., with a speed of 20 knots, has also completed her trials; she was constructed at Ferrol. Three torpedo cruisers, the Dona Maria de Molina, Alvaro de Bazan, and the Marques de la Victoria, are under construction at the Villa de la Grana Works at Ferrol; the first two of these have been launched, the last named having taken the water on the 14th September of this year. All three vessels are identical, being 235 feet long, with a beam of 26 feet, a maximum draught of 10 feet, and a displacement of 823 tons. The engines are to develop 2500 I. H. P., under natural draught, giving a speed of 17 knots, and 3500 I. H. P. under forced draught, with a speed of 19.5 knots. The armament will consist of two 4.7-in. Hontoria Q. F. guns (Loma system), four 3-pounder Nordenfeldt Q. F. guns, and two Hotchkiss machine guns. There is a torpedo tube in the stern and two torpedo tubes on deck. Under construction at Thomson's, Clydebank, are four torpedo-boat destroyers of the Terror type; two of these, the Audaz and Osado, have already successfully completed their steam trials; while the other two, the Pluton and Proserpina, are approaching completion. The battle-ships Pelayo, Numancia and Vitoria, which have been undergoing extensive repairs and alterations at the La Seyne Yard, Toulon, are to be completed for sea by the end of the year. The second-class cruiser Navarra is to be employed as cadet training-ship at Carthagena. Fourteen ships have been struck off the strength of the navy, among them the two frigates Lealtad and Concepcion, and the armored frigate Duque de Tetuan, and the monitor Puigcerda.

Personnel.

The number of officers on the active list, as fixed by the royal decree of 21st June, 1897, is as follows: 1 admiral, 6 vice-admirals, 15 rear-admirals, 24 captains (first class), 47 captains (second class), 87 commanders, 117 lieutenants (first class), 313 lieutenants, 224 sub-lieutenants.

For the marine infantry: 1 major-general in command, 4 brigadiers, 12 colonels, 16 lieutenant-colonels, 32 commandants, 140 captains, 164 lieutenants, 80 sub-lieutenants. The marine infantry consists of 3000 men, divided into 3 regiments, of 2 battalions of 4 companies each, of which the headquarters are stationed at Carthagena, Cadiz and Ferrol; 1 demi-brigade is in Cuba, and 2 battalions in the Philippines.—*Journal of the Royal United Service Institution.*

Fortifications.

In the Budget for 1897-98 a sum of 2,000,000 pesetas is devoted to the improvement of the fortifications and at the following ports: Cadiz, 105,000 pesetas; the fortified lines opposite Gibraltar, 60,000 pesetas; Carthagena, 331,000 pesetas; Barcelona, 125,000 pesetas; Ferrol, 250,000 pesetas; Palma (Majorca), 225,000 pesetas; Port Mahon, 360,000 pesetas; Uanta Cruz de Teneriffe, 109,000 pesetas; Las Palmas, 385,000 pesetas; Ceuta, 450,000 pesetas; and Melilla, 100,000 pesetas.

Pluton.

The official trials of the Spanish torpedo-boat destroyer Pluton, constructed by the Clydebank Engineering and Shipbuilding Company, Limited, to the order of the Spanish Government, have been successfully completed. The Pluton is 225 ft. long, and is thus somewhat larger

than the latest class of British torpedo-boat destroyers. She is, therefore, enabled to carry a considerably greater deadweight, the actual load on board during the trials being 73 tons. The results of the trial gave a mean speed of 30.12 knots on the measured mile, and during a continuous run of 1½ hours a speed of 30.02 knots was maintained. At the conclusion of the forced-draught trial the vessel was, according to contract, run for a further period of two hours under natural draught, the speed attained being 22.7 knots, or $\frac{7}{10}$ knot over the contract. During the tests there was a noticeable absence of vibration, and the engines worked to the entire satisfaction of the Spanish Commission. A sister ship, the Proserpina, has been launched from the Clydebank yard.—*Engineering.*

[United States.]

Progress of the Navy.

The progress of the new navy is shown in a tabulation recently made public by Chief Naval Constructor Philip Hichborn, U. S. N. At the beginning of 1897 the armed force afloat, neglecting all but the vessels of the new navy constructed since 1883, consisted of 3 first-class battle-ships, 2 second-class battle-ships, 18 cruisers, 7 gunboats, 6 double-turreted coast-defense armor-clad vessels, 3 torpedo-boats, 2 dispatch boats, and the ram Katahdin. During the first ten months of 1897 there were added to this force 1 battle-ship, 8 gunboats, and 3 torpedo-boats, or 12 new vessels in all. There are now under construction 5 first-class battle-ships, 1 gunboat, 16 torpedo-boats, and 1 submarine torpedo-boat. The names of these vessels now under contract, their builders and the state of progress on each are shown in the following table:

Name.	Builder and city.	Work completed.
	Battle-ships.	
No. 5. Kearsarge	Newport News, Va	45%
No. 6. Kentucky	Newport News, Va	44%
No. 7. Illinois	Newport News, Va	24%
No. 8. Alabama	Cramp & Sons, Philadelphia	25%
No. 9. Wisconsin	Union Iron Works, San Francisco	19%
	Gunboat.	
No. 13. Princeton	Dialogue & Son, Camden, N. J	91%
	Torpedo Boats.	
No. 4. Rodgers	Columbian Iron Works, Baltimore	96%
No. 5. Winslow	Columbian Iron Works, Baltimore	90%
No. 8. Rowan	Moran Bros., Seattle, Wash	83%
No. 9. Dahlgren	Bath (Me.) Iron Works	8%
No. 10. T. A. M.	Bath (Me.) Iron Works	8%
No. 11. Farragut	Union Iron Works, San Francisco	11%
No. 12. Davis	Wolff & Zwicker, Portland, Ore	58%
No. 13. Fox	Wolff & Zwicker, Portland, Ore	46%
No. 14. Morris	Hereshoff Manufacturing Company, Bristol, R. I	0%
No. 15. Talbot	Hereshoff Manufacturing Company, Bristol, R. I	48%
No. 16. Gwin	Hereshoff Manufacturing Company, Bristol, R. I	48%
No. 17. Mackenzie	C. Hillman Co., Philadelphia	60%
No. 18. McKee	Columbian Iron Works, Baltimore	20%
No. 19.*	Harlan & Hollingsworth, Wilmington, Del	0%
No. 20.	Wolff and Zwicker, Portland, Ore	0%
No. 21.	Gas Engine & Power Co., N. Y	0%
	Submarine Torpedo Boat.	
No. 1. Plunger	Columbian Iron Works, Baltimore	61%

The completion of these vessels will make the total number of vessels in the new navy 77.—*R. R. Engineering News.*

*Secretary Long has christened the 30-knot torpedo boats as follows: No. 19 to be called Stringham, No. 20 the Goldsborough and No. 21 the Bailey.

Winslow.

The trial trip of the torpedo-boat Winslow, built by the Columbian Iron Works, of Baltimore, was a success. The contract required the boat to make 24½ knots an hour on a trial run of two consecutive hours. She accomplished the test with 24.8 knots to her credit, leaving, as one of her critics expressed it, a safe margin by which her speed is to be computed. The highest speed she made on the run was 25.2 knots, while she was on the first half of the course, with a strong wind in her teeth. She did not seem to be affected by the conditions of the sea, and made her speed apparently independent of them.

BOOK NOTICES AND REVIEWS.

JOURNAL OF THE UNITED STATES ARTILLERY, September to October, 1897, Vol. VIII, No. 2, Whole No. 28. Artillery School Press, Fort Monroe, Va.

1. The Probability of Hit when the Probable Error in Aim is known, by Professor Mansfield Merriam, Professor of Civil Engineering in Lehigh University.

Professor Merriam deduces the necessary formulas and compares the probability of hitting when independent or parallel fire is used from mortar batteries, the data being taken from the five groups of shots fired at Sandy Hook and Fort Monroe and published in the *Journal of the United States Artillery* for May-June, 1897, Vol. VII, pp. 287-346. By independent fire is meant when several shots are fired from a single mortar, or when a volley is fired from several mortars of a battery, each mortar being independently aimed in azimuth and range with the intention of hitting the centre of the deck of the ship. By the term parallel fire is understood that method in which all the mortars of a battery are aimed parallel to an imaginary mortar at the centre of the battery, this imaginary mortar being aimed in azimuth and range with the intention of hitting the centre of the deck of the ship.

Using the data given, the conclusion reached is that the superiority of the independent method over that of the parallel method is about 16 per cent when the ship is on the principal axis of the battery, and about 37 per cent when it has an azimuth of 45° with respect to the principal axis. "In the long run, then, it has about 25 per cent advantage; that is, the average probable number of hits by the parallel method is only about four-fifths of the average probable number of hits when all the mortars of the battery are fired by the independent method."

2. A reply to the report of a Board on Sea-coast Mortar Fire, by J. T. Honeycutt, First Lieut., First Artillery.

Lieut. Honeycutt quotes opinions of Professor Merriam of Lehigh University and Professor Johnson of the Naval Academy, authors of standard works on probabilities, and gives additional arguments in support of his conclusion as expressed in his paper entitled "Parallel and independent fire, with special reference to mortar batteries," that "the probable number of hits from a battery of mortars will be greater if the mortars are aimed independently at the target than would be the case were the mortars aimed by the parallel method."

3. The Theoretical and Practical Training of the Light Artillery Gunner, by First Lieutenant Charles B. Satterlee, Third Artillery.

4. Indirect Fire, a lecture delivered before the Militärwissenschaftlichen und Casino-Vereine zu Temesvar, by Major-General Moriz Edler von Reichold. A translation by Second Lieutenant J. A. Shipton, First Artillery. Description and discussion of the methods and means of laying field

guns from positions hidden from the targets by accidents of ground, and conclusions drawn as to what circumstances would warrant its use.

5. History of the Sea-coast Fortifications of the United States, III. Narragansett Bay, by General George W. Cullom, Engineers. R. R. I.

Conclusions upon Questions in Naval Tactics (Razsujdenia po Voprasam Morskoi Taktiki), by S. O. Makarof, Vice-Admiral, Russian Navy.

Under the above heading an important work by Admiral Makarof has recently been published by the Admiralty Press at Saint Petersburg. In a volume of two hundred and fifty octavo pages a great number of matters affecting chances of success in war are described. The book suggests a very modern treatise upon naval seamanship, and from its perusal one is led to conclude that success in naval battle will be largely dependent in the future, as it has been in the past, upon deriving the greatest advantage from existing conditions of wind, weather, sea and position. Admiral Makarof's work is characterized by its advocacy of war efficiency in contradistinction to peace expediency; by its subordination of matters purely technical to tactical conditions; and by its advocacy of pluck, push and the voluntary incurring of risk when the odds are favorable to the successful attainment of an end sought.

An idea of the scope of the treatise may be had from the headings of the chapters into which it is divided, and which are as follows:

The place of naval tactics in the list of naval sciences; Influence of morale upon success in battle; Naval and military pedagogics; Self-training and education; Instruction of the personnel afloat; The gun; The torpedo; The ram; Preparation for battle; Miscellaneous operations; Single combat; Fleet action; Night torpedo attack; Information upon various naval matters. J. B. B.

Yankee Ships and Yankee Sailors. Tales of 1812. By James Barnes. Illustrated by R. F. Zogbaum and Carlton T. Chapman. Published by the Macmillan Company, 66 Fifth Ave., New York. Price $1.50.

The crowning merit of this work is the authenticity of the tales. Many of them are historical and are familiar to students of American history; but they are presented by the author in so attractive a garb, with the introduction of new details and substantiating facts gathered from state papers and official correspondence, that every page holds the attention of the reader. Be the latter seaman or landsman, the perusal of these tales fills him with pride in the Yankee sailor of 1812, that representative type of the sturdy American seaman whose gallant deeds have become historic. Every one of the tales is fascinating. The author is to be congratulated upon his delightful contribution to sea-lore.

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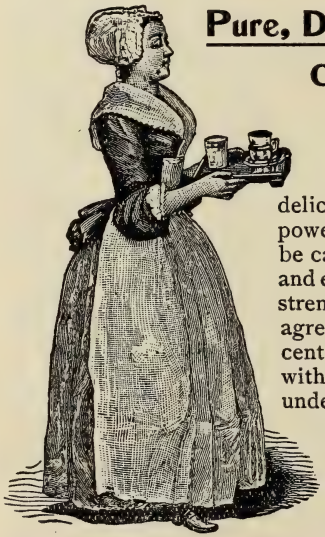

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NOVEMBER 19. Russia and the Turkish Fleet. British, French and German Armor. The Velocity and Pressure of the Wind, and its Measurement. Sheathing or Feathering Propellers. H. M. S. Leander. Technical Education. Electrical Power Development. Special Steels for Ship and Boiler Construction. American Armor-piercing Projectiles. Steamship Lengthening in Germany.

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2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1899. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

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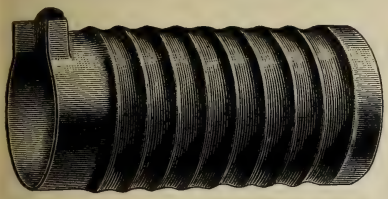

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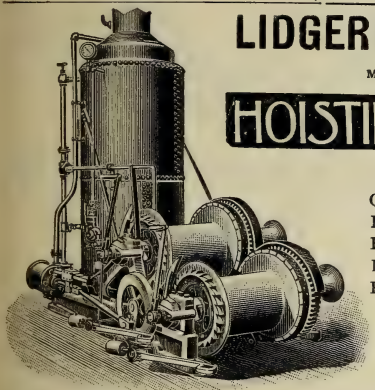

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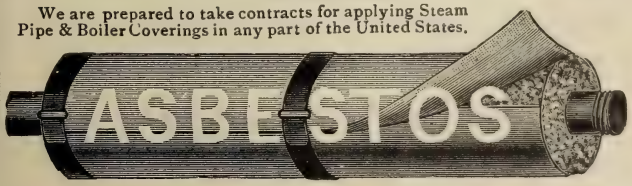

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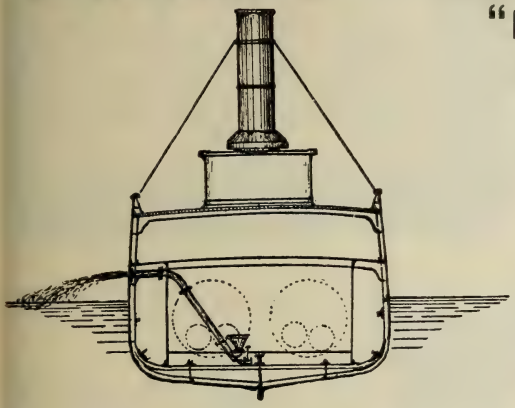

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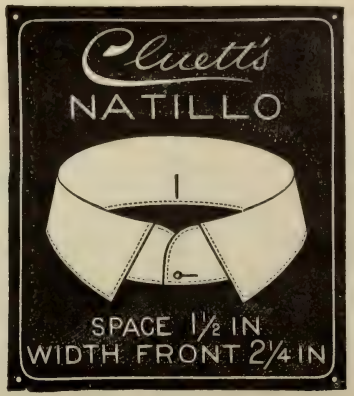

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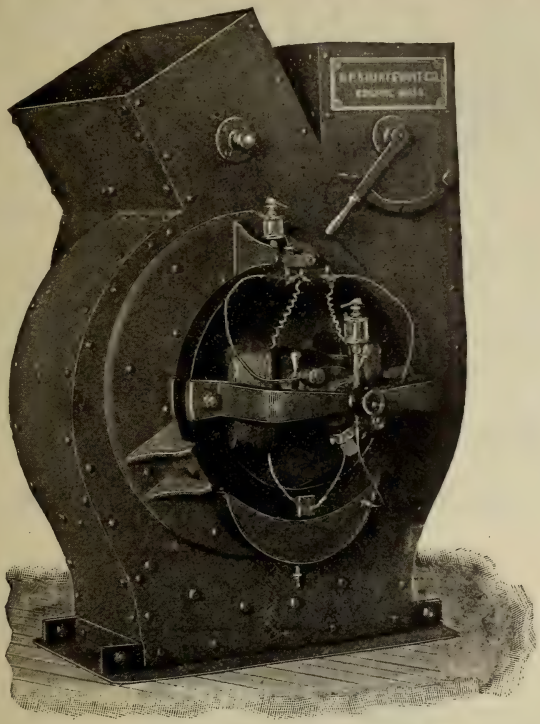

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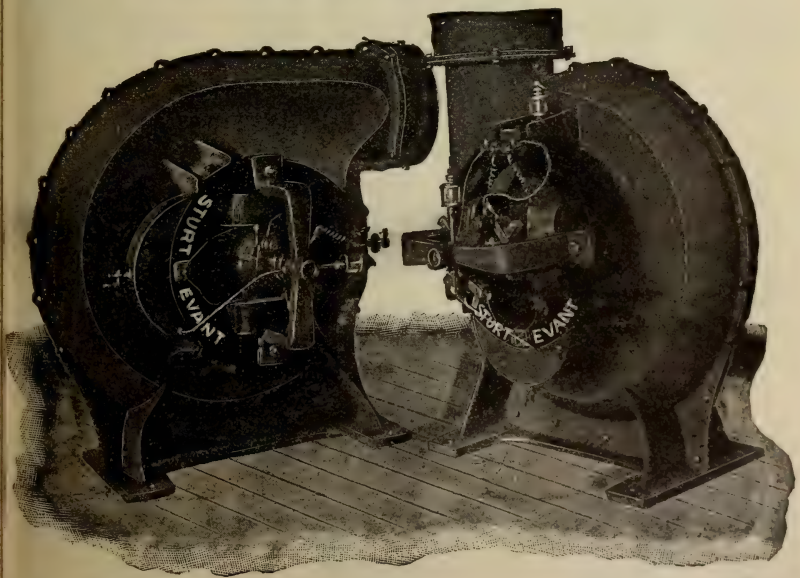

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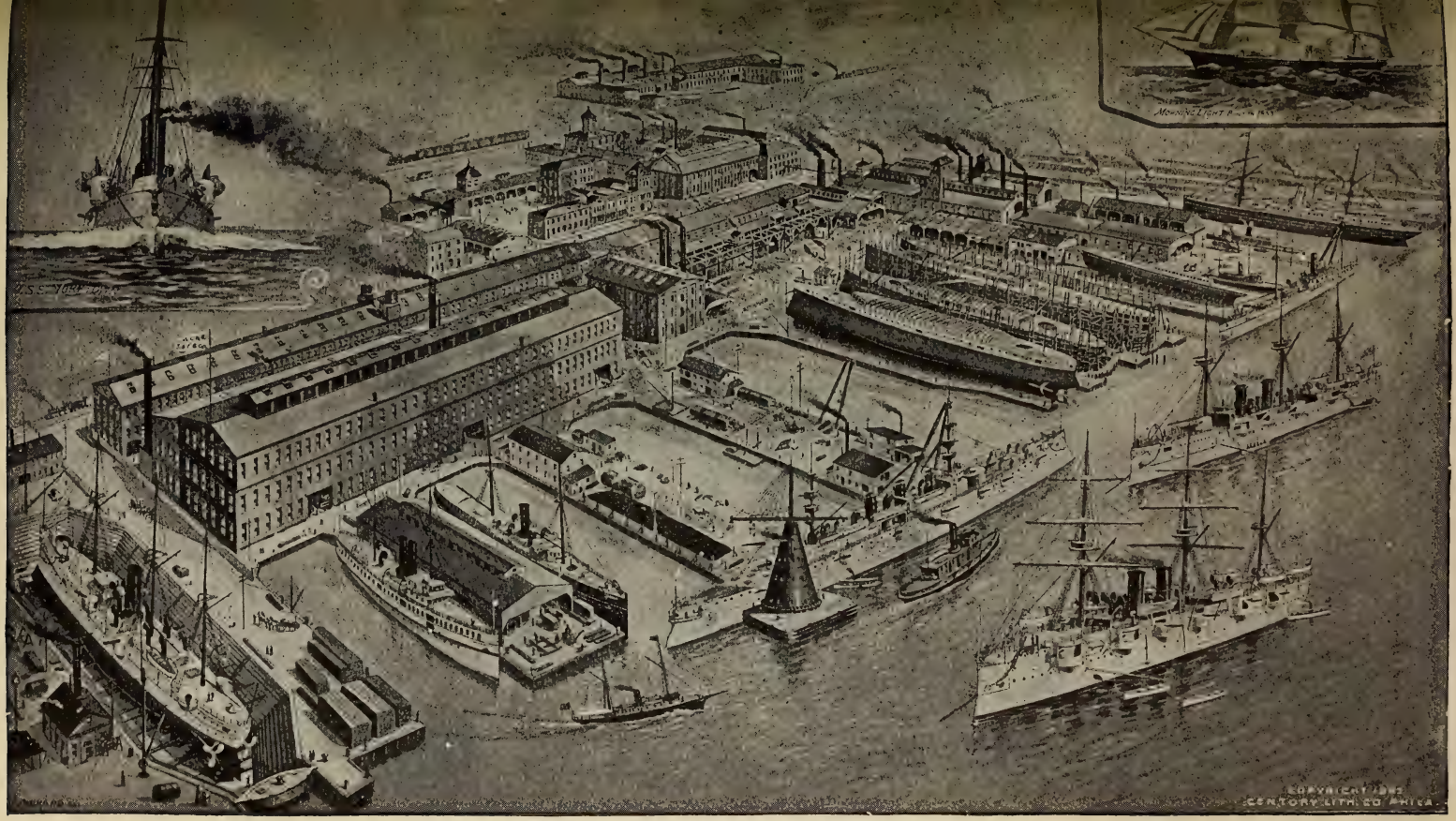

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